1988 ANNUAL REPORT

Alberta

OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY

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Alberta
OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY

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TO HER HONOUR
HELEN HUNLEY
LIEUTENANT GOVERNOR OF THE PROVINCE OF ALBERTA

Madam:

I have the honour to submit the Annual Report of the ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY for the fiscal year ended March 31, 1988.

Respectively submitted

Neil Webber.

NEIL WEBBER
Minister of Energy

Foreword

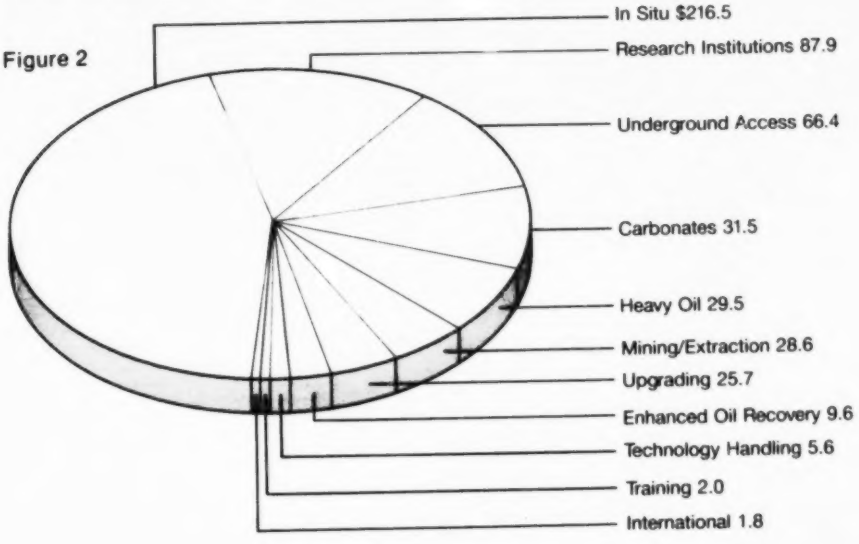
On January 14, 1974, the Premier of Alberta announced the availability of $100 million to develop new technology for the recovery and processing of petroleum from the Alberta oil sands The terms and conditions for the disbursement of these funds are described in The Oil Sands Technology and Research Authority Act, passed by the Legislature in June 1974 and since amended to include the recovery of heavy oils and the enhanced recovery from conventional petroleum reservoirs. Additional funds have since been dedicated by the Alberta Government to permit the funding of longer term programs.

AOSTRA Field Pilot Projects

Figure 1

Commitments from AOSTRA Research Fund To March 31, 1988 ($ Millions)

Figure 2



Report of the Chairman and Chief Executive Officer

To The Honourable Neil Webber
Minister of Energy

Sir:

I have the honour of presenting the Annual Report of the Alberta Oil Sands Technology and Research Authority (AOSTRA) for the year ended March 31, 1988.

During the 1987-88 fiscal period, AOSTRA expended $12.8 million on in situ oil sands recovery development and results in this program continue to be very encouraging. Oxygen combustion technology developed at the AOSTRA/BP Marguerite Lake Pilot Project, is the basis for the nearby Wolf Lake expansion project being undertaken by BP and Petro-Canada. The novel fracturing/injection methods also developed at the Marguerite Lake Pilot led to the drilling of an additional 22 wells in an area adjacent to the Wolf Lake operation and now steam stimulation has commenced in this project. Test results from the AOSTRA-Canterra-Tenneco and AOSTRA-Bow Valley Resources-Cold Lake Heavy Oil pilots have been encouraging enough to extend testing through 1988.

In 1982, AOSTRA initiated a study for an underground concept which would use shaft and tunnel methods for placing horizontal wells in an oil sands formation for the purpose of in situ bitumen recovery, and in 1984 committed to the construction of an Underground Test Facility (UTF). In 1986, unable to obtain industry participation, AOSTRA committed to initiating a limited Phase A process testing program. In August, 1987, following a very successful drilling program, AOSTRA renewed the offer of participation and by year-end all options had been spoken for, with additional methods of participation now being considered.

During the past year, significant developments have occurred on the AOSTRA-owned Taciuk Direct Thermal Processor technology. With the technology now suitably developed and ready for field demonstration, AOSTRA is continuing discussions with potential users for mined oil sands applications in Alberta and internationally. Tests from two non-oil sands applications generated a substantial degree of interest, and have resulted in: plans to construct a demonstration scale plant in Queensland, Australia for use in processing oil shales; and the granting by AOSTRA of licensing rights for use of the technology in the treatment of hydrocarbon-bearing solid waste materials.

AOSTRA has also reviewed a number of alternative mining and extraction methods in the hopes of developing an optimal method to lower costs of bitumen production. In partnership with Shell Canada Ltd., tests have been conducted on the Solv-Ex Process and evaluations are now being carried out. AOSTRA and the OSLO group are evaluating the use of dredge mining to develop a compatible cold water extraction process. Together with the National Research Council and Terra Energy, AOSTRA is preparing a cost estimate for a demonstration plant to test the SESA Process.

Demonstration tests of VEBA Oel's VCC Process were done with both Cold Lake heavy oil and Athabasca bitumen. Both tests were considered successful. They provide an excellent design database and increased confidence that the processes are ready for commercial application for heavy oil upgrading in Alberta. Further testing this year on Gulf's DRB Process and HRI's H-Oil Process also provided useful information for further development.

AOSTRA continues to fund research at other institutions and at Canadian universities, resulting in commitments in excess of $8.7 million during this fiscal period.

At its annual review of priorities, AOSTRA decided to place increased emphasis on enhanced recovery of conventional oil and on the maintenance of environmental quality during and after oil sand and heavy oil operations. Several new enhanced recovery projects are under negotiation, and a separate section on Environmental Activities has been incorporated into the Annual Report for the first time.

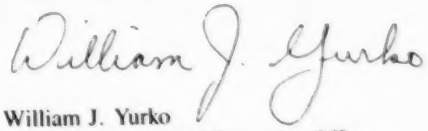
In our continuing effort to make foreign agencies aware of Canadian technology and services, AOSTRA cosponsored the 1987 China-Canada Heavy Oil Symposium.

Representatives from Canadian companies and government agencies travelled to China to present technical papers and initiated potential contracts for services. AOSTRA maintains ongoing contacts with many other countries, which have resulted in exchanges of technical experts and technical information. As host for the 4th UNITAR/UNDP International Conference on Heavy Crude and Tar Sands we have approached our many related agencies around the world requesting papers on the latest technological developments, and we are very pleased with the response and look forward to a very successful conference in August 1988.

On November 30, 1987 Mr. Maurice Carrigy retired. As Vice Chairman of AOSTRA since its beginning in 1974, Mr. Carrigy provided a wealth of experience and knowledge of oil sands development in Alberta. He will be missed by the AOSTRA staff. Dr. Ernie Wiggins was appointed Acting Vice Chairman effective December 1, 1987. Dr. Wiggins has been an AOSTRA Member since 1977 and his extensive experience and knowledge of AOSTRA affairs will be relied upon extensively until a permanant Vice Chairman is named.

Mr. Minister, at this time I would like to thank the AOSTRA staff for their diligence during the past year. It has been a pleasure for me to come to know and work with the staff during my first year with AOSTRA.

Respectfully submitted



William J. Yurko
Chairman and Chief Executive Officer

The Hon. P.N. Webber and Members of the Authority
Standing: J.M. Richardson, R.S. Aberg, F.A. Kidd, E.J. Wiggins, J.E. Miller.
Seated: W.J. Yurko, The Hon. P.N. Webber, S.P. Zarusky.

Members of the Authority

Chairman
Mr. W.J. Yurko

Vice-Chairman
Mr. M.A. Carrigy *
Dr. E.J. Wiggins **

Members
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Dr. H.E. Gunning +
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Report of Activities

1 In Situ Oil Sands Recovery Program

1.1 AOSTRA-AMOCO Gregoire Lake Pilot Project

In 1984, AOSTRA, Amoco Canada Petroleum Company Limited, and Petro-Canada Exploration Inc. signed an agreement to conduct a new in situ pilot approximately 15 km northeast of the former Block 1 pilot using steam and steam combined with additives. Operation commenced in late 1986 in the four-spot pattern of injection, production and observation wells. The operations have been extended to continue throughout 1988. A unique feature of the project is that the initial heat front movement in the reservoir was tracked through the application of 3-D seismic monitoring over the pilot area.

1.2 AOSTRA-BP Marguerite Lake Pilot Project

The Marguerite Lake pilot project is located in the Clearwater sandstone of the Cold Lake oil sands deposit, and is designed to test steam stimulation followed by wet combustion. The project is operated by BP Exploration Canada Limited with AOSTRA, Dome Petroleum Limited and PanCanadian Petroleum Limited, as partners.

The project has now completed its ninth year of operation. The initial steam stimulation phase and concurrent combustion testing with air in special test wells is complete. Feasibility studies led to a decision to use oxygen instead of air for the combustion phase, and a total of five wells in the main pattern were converted to oxygen injection. Oxygen injection and related production operations continued into 1987 with encouraging results. The first phase of the project was completed on March 31, 1987 and AOSTRA plans to participate in the extension phase of the project which is being conducted by BP.

BP is investigating the use of the oxygen combustion technology in the Wolf Lake 1100 m^3/day operation which surrounds the pilot area. The Wolf Lake project, which started production in April 1985, is based on steam recovery technology developed at the Marguerite Lake pilot.

1.3 AOSTRA-BP B-Unit Pilot Project

The B-Unit pilot is a single-well cyclic steam stimulation project with two observation wells in the Lower Grand Rapids formation of the Cold Lake oil sands deposit. The producing zone is 16 m thick at a depth of 430 m. The pilot is operated by BP Exploration Canada Limited with AOSTRA and Petro-Canada Inc. The object of the testing is to improve bitumen recovery by novel fracturing/injection methods which were developed at the AOSTRA-BP Marguerite Lake pilot, 10 km to the north. This has been accomplished with the completion of the fourth cycle.

Based on the encouraging results of the B-Unit pilot, BP and Petro-Canada have drilled 22 wells for production from the Lower Grand Rapids formation at a location adjacent to the Wolf Lake operation. Steam stimulation operations have commenced in this project.

1.4 AOSTRA-CANTERRA-TENNECO Kearl Lake Pilot Project

Canterra Energy Ltd. is the operator of the Kearl Lake pilot project with AOSTRA and Tenneco Energy Ltd. as participants. The pilot is located 77 km northeast of Ft. McMurray.

The pilot is testing a steam drive process in the McMurray oil sands which in this area is at a depth of 150 m and is about 43 m thick. The pilot consists of two patterns. The "A" pattern is an inverted seven-spot with seven steam injection wells and six producers. The "B" pattern was infill-drilled based on "A" pattern information forming an inverted nine-spot. Operations began in the "B" pattern in 1985. The "B" pattern operations were expanded in 1987 to provide two additional inverted five-spot patterns, plus observation wells adjoining the existing nine-spot pattern. Steam additives were tested in 1987 to improve recovery operations. Both "A" and "B" patterns operated throughout 1987 with encouraging results.

1.5 AOSTRA-COLD LAKE-BOW VALLEY Pilot Project

Bow Valley Resource Industries Ltd. with AOSTRA and Cold Lake Heavy Oil Ltd. operate a pilot in the Cold Lake area of northeastern Alberta which was designed to test the use of superheated steam, plus carbon dioxide and clay stabilization additive, for recovery of bitumen from the Cold Lake Clearwater horizon.

Following preliminary laboratory and field studies, pilot operations using a modified recovery process were started in an inverted seven-spot pattern in 1984. The pilot results were encouraging and a second inverted seven-spot pattern on larger spacing plus two special test wells were drilled in 1986. The original inverted seven-spot pattern operated throughout that year and operations in both patterns, plus the special test wells will continue during 1988.

1.6 AOSTRA-SHELL Peace River Pilot Project

The AOSTRA-Shell Canada Resources Limited-Shell Explorer Limited-Amoco Canada Petroleum Company Ltd. Peace River Project located 30 km northeast of Peace River, was designed as a prototype installation to test a modified steam drive recovery process in the Peace River oil sands. The recovery technology is based on cyclic steam pressurization and modified drive in the 27 m thick oil sands at a depth of 550 m via a 3 m bottom interval of high water saturation and has been successful in this test. Steam stimulation and the first and second pressurization/production cycles have produced approximately 33% of the original oil-in-place. The third pressurization/production cycle began in 1986 and will continue into 1988.

Shell Canada has constructed a commercial demonstration project with a capacity of 1600 m^3/day, using the project technology and incorporating the existing pilot facilities. AOSTRA's and Amoco's direct participation terminated at the end of 1985, but AOSTRA continues to receive data from the commercial project.

1.7 AOSTRA-SUNCOR-CANADIAN WORLDWIDE Fort Kent Steam Additive Study

AOSTRA, Suncor Inc., and Canadian Worldwide Energy Limited completed a combined engineering feasibility study on the use of steam additives to improve oil recovery at the Suncor Fort Kent commercial demonstration operation in Cold Lake. The study evaluated the patented steam plus carbon dioxide and naphtha additive process developed by AOSTRA at the Alberta Research Council. The results indicated that additional recovery could be achieved with the steam additive system although the process is not economically attractive at current oil prices. The study report was completed in 1987.

1.8 AOSTRA-UNOCAL Buffalo Creek and McLean Pilot Projects

These projects are located approximately 100 km west of Ft. McMurray and are operated by Unocal Canada Limited with AOSTRA and Canadian Superior Oil Limited. Tests have been conducted since 1977 in the Grosmont 2 and 3 Devonian carbonate formations to examine the suitability of steam stimulation, steam drive, and wet combustion processes for bitumen recovery.

Tests in a five-spot pattern (McLean pilot) were completed in 1983. The initial results indicated a geological anomaly within the pilot area. In order to maintain the initial pilot concept, two additional wells were drilled in early 1984 and operations continued through 1985. Late in 1985, two new production wells for cyclic steam operations were drilled at locations offsetting McLean and were operated throughout 1986. A special test program was conducted in 1986 to investigate the relationship of geology to well operation at the McLean pattern. The 1986 field program gave mixed results and field operations were suspended until an analysis of all pilot data could be carried out. This will be completed during 1988.

1.9 TEXACO Ft. McMurray Horizontal Well Project

AOSTRA acquired production and operating data on three horizontal wells operated by Texaco Canada Inc. in the Athabasca formation near Ft. McMurray, and has completed the analysis of this pilot data.

AOSTRA is currently pursuing horizontal well technology for recovery of bitumen at its underground test facility northwest of Ft. McMurray.

1.10 AOSTRA-INDUSTRY Mineralogical Transformation Study

AOSTRA was the operator in a cooperative industry-supported research program with eight other industrial participants to conduct a state-of-the-art review of the available confidential and public information on mineralogical transformations occurring during thermal recovery. RES-SEN Reservoir Technology Limited was the contractor conducting the review for the first phase of the study at a cost of $55,000. The study was completed in 1986 and a review by the participants in 1987 led to a decision not to initiate further research at this time.

1.11 Data Base Management System

The AOSTRA Date Base System (ADBS II) was placed in full operation during 1987. ADBS II provides entry, storage, reporting and retrieval of data collected by in situ pilot projects. The system is used by project operators, project participants and AOSTRA internally. At the end of 1987, over fifty years of project data were resident within ADBS II, representing the daily operations of ten in situ pilot projects. Additional data from several projects are archived on tape, and may be used to create online data bases within ADBS II in the future.

The ADBS II uses a relational data base management system and is maintained on a mini computer located at AOSTRA's Calgary office. Authorized users can use the system in "time share" mode to access data from projects in which they are participants. In addition, the ADBS II software has been installed and licensed on computers located in the offices of project participants.

Features of ADBS II include use of menus to simplify entry of commands, fast response time to large volume data searches and a comprehensive report package customized for each project. AOSTRA Computer Services staff provide ongoing support and enhancements to the system. AOSTRA welcomes inquiries from Industry regarding the licensing of ADBS II for in situ projects.

1.12 Economic Studies

An economic model for evaluating and monitoring the commercial potential of new and existing in situ production projects was developed and is now available for use on a microcomputer. The cost base will be updated as appropriate.

The model is currently being used by AOSTRA to evaluate the commercial potential of pilot project expansions.

The Canadian Economic Research Institute has been commissioned to evaluate the commercial potential of various projects and recovery processes. The study is expected to be completed in mid-1988.

2 Underground Test Facility (UTF)

Shaft and tunnel methods for placing horizontal wells low in an oil sands formation for the purpose of in situ bitumen recovery have been the subject of AOSTRA supported projects for more than ten years. In 1982, AOSTRA initiated a study for an Underground Test Facility (UTF) which would provide underground access for the testing of in situ recovery processes. Following extensive design studies and preliminary discussions with potential industry participants, AOSTRA committed to the construction of the UTF in 1984.

In 1985, further studies were carried out to confirm the preferred drilling and process testing program. These studies supported project feasibility and identified

a program to approach the testing in two discrete stages. At the same time, work was undertaken on the engineering and fabrication of a custom drilling rig designed to place long horizontal wells from the constrained environment of the underground tunnel system.

In early 1986, economic conditions in the industry were at a low point and AOSTRA committed to initiating a limited Phase A testing program without industry participation. During that year, the surface process facilities were designed and constructed and the underground tunnel system was extended to provide access to drilling chambers. The custom drilling rig was completed and field tested before being reassembled down the mine for the drilling of the process test wells. Following the drilling of the initial horizontal well, the Federal Department of Energy, Mines and Resources had joined the project as the first technical participant in the Phase A process tests and cosponsor of an enhanced geotechnical program.

This fiscal year has been a very active one for the project in terms of both technical development and industry participation. Ongoing discussions with Chevron Canada Resources Limited resulted in the company becoming a participant in the Phase A program and a further separate test of the Chevron HASDrive Process, cosponsored by Chevron and AOSTRA, was added to the UTF project.

By November 1987, all facilities were complete, including the added HASDrive wells and equipment, and both process tests were into start-up. The underground horizontal well drilling program went through a steep learning curve, with the drilling of three horizontal "twin well" sets (a total of six wells) for the Phase A program, plus two tightly located HASDrive wells. An extensive 30-well surface drilling program was carried out to accommodate geotechnical and process observation instrumentation. This program was successful and included the development of some first ever geotechnical instrumentation applications.

With the project moving towards process start up, AOSTRA renewed the offer of participation to industry in late August 1987. The expanded UTF program proved to be of great interest to industry and by year end the original offering of participation options had been committed to the Federal Government and six major oil companies. Additional methods of industry participation are now being considered.

Project activity is currently centered on process start-up and moving into an established operating mode. The presently committed test programs at the UTF will end in March 1989. It is expected that further work will be required, and AOSTRA will continue to develop any prospects with the participants.

3 Heavy Oil Recovery Program

3.1 AOSTRA-ALBERTA ENERGY Suffield Heavy Oil Pilot Project

Alberta Energy Company Limited (AEC) operates the Suffield Heavy Oil Project on behalf of AOSTRA, Dome Petroleum Limited and Westcoast Petroleum Limited. The project is located in the glauconite sandstone under the Suffield military block in southeastern Alberta. The wet combustion process was tested in an inverted five-spot pattern at a location where the 19.5 m thick heavy oil reservoir is underlain by water. During 1986, a single well gas injection test was conducted in conjunction with the combustion recovery operations following the addition of an off-set production well to the project.

Although pilot production was significantly greater than would be expected by primary recovery alone, the combustion operations were suspended at the end of 1986 in order to concentrate on an alternate recovery process. During 1987 and early 1988, AOSTRA, Dome and Westcoast Petroleum conducted field testing of a modified non-thermal gas drive process in an inverted seven-spot pattern plus two special single well tests at locations offsetting the original combustion test pattern. Testing of the process will continue through 1988.

3.2 AOSTRA-NORCEN Bodo Field Pilot

A comparison of steam flooding versus in situ combustion is being conducted in the Bodo field in east central Alberta by AOSTRA, Norcen Energy Resources Limited, Texaco Canada Resources, Murphy Oil Company Limited, and Canadian Occidental Petroleum Limited. The nine-spot steam pilot is similar in configuration and offsets the original combustion pattern which was operated by Norcen until 1984. The steam pilot began operations in mid-1985 and continued throughout 1987 with encouraging results. Operations will continue throughout 1988.

4 Enhanced Recovery Program

4.1 AOSTRA-CANTERRA Asphaltene Solids Precipitation

Canterra Energy Limited is the operator of a jointly supported research program with AOSTRA to conduct a laboratory study of the precipitation of asphaltenes in selected light oils when contacted by hydrocarbon solvents. An important goal of the study is to formulate a mathematical model using an equation of state and data obtained from asphaltene solubility tests to predict the deposition of asphaltenes under variable pressure and temperature conditions. The first phase of the study was completed in 1987 at a cost of $190,500 with Hycal Energy Research Laboratories as the contractor.

A second phase of the study to further characterize the solids precipitate phase and to extend the applicability of the equation of state model that was developed in the first phase of the study to a wider range of oil types will be conducted in 1988 at an estimated cost of $111,980.

4.2 AOSTRA-HUDSON'S BAY (DOME) Cessford Caustic Polymer Flood Test

In 1981 AOSTRA acquired results from Hudson's Bay Oil & Gas Limited (now Dome Petroleum Limited) of earlier tests conducted in the Cessford Basal Colorado "A" Pool. These single well tracer tests determined that the technique was effective for measuring residual oil saturation before and after caustic flooding.

Further laboratory tests conducted by Hudson's Bay, indicated oil recovery could be improved with the addition of polymer to the caustic flood.

AOSTRA agreed in 1986 to participate in the pilot testing of caustic-polymer injection and these tests are expected to continue through 1988. The gross cost for the incremental caustic-polymer water flood is estimated to be $4.9 million.

4.3 AOSTRA-PANCANADIAN Countess "B" Combustion Pilot

PanCanadian Petroleum Limited and LL&E Canada Limited are partners in the Countess "B" pilot which is being conducted to evaluate a wet combustion recovery process in the waterflooded Countess Upper Mannville "B" pool near Brooks, Alberta. PanCanadian is the operator of the field project. Pilot operations continued with encouraging results during 1987.

AOSTRA is funding a research program to support the pilot activities. The supporting research program included combustion-tube tests, emulsion treating studies, geological studies, behind-burn core well, corrosion studies, combustion front mapping, numerical modelling and core flow test for process evaluation. The supporting research program will continue through 1988.

4.4 AOSTRA-D.B. ROBINSON AND ASSOCIATES-INDUSTRY Slim Tube Study

AOSTRA is the operator of a cooperative industry-supported research program to investigate the use of slim tube tests to evaluate conditions of miscibility in miscible floods. D.B. Robinson and Associates Ltd. is the contractor for the project. The project is financially and technically supported by 10 industrial companies and AOSTRA. The objective of the project is to develop equipment and demonstrate the feasibility of collecting and analyzing small samples of flowing fluids in a slim tube experiment, particularly in the transition zone between the oil and the solvent. Equipment design and fabrication was completed in 1987. Testing of the equipment will continue through 1988.

4.5 AOSTRA-VIKOR RESOURCES Joffre Viking CO_2 Miscible Flood

Vikor Resources Limited is the operator on behalf of AOSTRA and the unit participants of the Joffre Viking CO_2 miscible pilot. This pilot is located in a previously waterflooded and abandoned segment of the Joffre Viking (lower Cretaceous) sandstone reservoir in central Alberta. The pilot is testing the ability of a CO_2 miscible flood to recover tertiary oil from a 3 m thick, previously waterflooded reservoir containing light gravity oil.

The initial pilot consisted of two five-spot patterns each covering 65 ha and CO_2 injection commenced during 1984. CO_2 injection alternating with water injection (WAG Process) for mobility control continued until October 1986. Water injection is being continued in the two patterns. Production response to CO_2 injection was evident during 1984. In 1986, a third well was converted to CO_2 injection to improve oil recovery near the edge of the reservoir.

Gross costs for the first phase of the project which was completed in January 1988 were $15.1 million. The results of the pilot have been encouraging and plans for expansion have been initiated and are expected to commence in 1988. In addition, a mobility control test is being planned in the original pilot area.

A commercial expansion consisting of eight wells in an area offsetting the pilot was completed in 1985. The Joffre Viking CO_2 flood is the first miscible CO_2 flood to be conducted in Canada.

4.6 CANADIAN WESTGROWTH LIMITED Retlaw Upper Mannville "B" Immiscible CO_2 Project

Canadian Westgrowth Limited is the operator of the Retlaw Upper Mannville "B" Unit Immiscible CO_2 Project which is located near Lethbridge. The objective of this project is to evaluate the performance of a CO_2 immiscible flood in a medium gravity oil reservoir. The injection of CO_2 which commenced in 1983 will continue through 1988. This is the first immiscible CO_2 flood to be conducted in Canada.

AOSTRA continues to acquire operating data on the project and is analyzing the performance of this project.

5 Produced Water Recycling Program

5.1 Peace River Produced Water Treatment Pilot Project

Shell Canada Limited's initiative in the Peace River in situ oil sands includes a pilot program to operate a small steam generator on water coproduced with bitumen from the steam stimulated in situ recovery operations. AOSTRA has contributed 35% of the $2.5 million funding of the water treatment and steam generation test program which treats the produced water for oil and hardness removal, but does not remove silica prior to feeding the steam generator.

Construction of the pilot was completed in June of 1987 and since that time, has completed four major test runs on the steam generator at increasing levels of silica concentration. The presence of scale in the radiant tubes during the fourth run has resulted in a reduction in the level of silica recommended for extended operation. A six month run of the steam generator is planned to begin in April 1988 and will evaluate the long-term operating characteristics of the system prior to making recommendations regarding the operation of Shell's commercial water treatment/steam generation facilities.

A series of tests on the operation of the ion exchange units has determined effective regenerator operation at target levels and frequency. Fouling of the ion exchange resins has occurred, but the extent of the reduction in capacity has not yet been determined.

5.2 Lindbergh Area Produced Water Treatment Project

The problems of sufficiently treating the water coproduced with bitumen at in situ recovery operations in order to permit water recycle for steam generation vary widely from one geological formation to another, and indeed vary greatly within regions of each formation. However, within the Blairmore zone in the Lindbergh area there is a problem - the removal of total dissolved solids (TDS) - which does not yet have a technically and economically feasible solution.

Possible methods for TDS removal include membrane processes, such as electrodialysis and reverse osmosis, and separation by way of phase-change, such as evaporation and freeze desalination. Phase I of this project was initiated in the fall of 1986 to test the efficiency and operating characteristics of a vapor compression evaporator (VCE) for TDS removal. Pilot testing of the VCE commenced in 1987 and was complete by mid-March, 1988. A final report is due later in 1988. Preliminary results of the pilot test show that TDS removal by evaporation is technically achievable, however, pretreatment of the VCE feed is necessary to stabilize the characteristics of the water. This may render the treatment more expensive than originally anticipated.

Phase I of the project will be carried out at a cost of $750,000 and is funded 50% by AOSTRA and 26% by Environment Canada with the five industrial participants (Murphy, Dome, Westmin, Amoco and PanCanadian) sharing the remainder of the project costs.

A proposal to conduct a field test using electrodialysis for TDS removal is planned as the second phase of this project. This proposal will be prepared by Environment Canada for the consideration of participants later in 1988.

6 Surface Mining/ Extraction Program

6.1 AOSTRA Taciuk Direct Thermal Processor

The AOSTRA Taciuk Processor is a dry retorting process that has been under development since 1977 by AOSTRA and UMATAC Industrial Processes Division of UMA Engineering Limited (UMATAC), for the simultaneous extraction and primary upgrading of oil sands bitumen. The AOSTRA-owned testing facility in Calgary consists of three batch testing units and a 105 tonnes/day continuous flow Taciuk Processor pilot. Over 12,000 tonnes of oil sands and other candidate feedstocks have been processed in the pilot plant. Significant developments of the process such as process scale-up and improved design of various mechanical features and sealing systems within the Processor itself, have been achieved this year. Since 1977, total project expenditures of approximately $17.0 million have been paid totally by AOSTRA.

This technology, which is owned by AOSTRA, is considered ready for field demonstration. To this end, AOSTRA continues to discuss the use of the AOSTRA Taciuk Processor for mined oil sands applications with potential industrial users.

Two non-oil sands applications which have generated a substantial degree of interest are the processing of oil shales and the treatment of hydrocarbon bearing solid waste materials.

Favorable results of earlier batch test work carried out at the AOSTRA pilot facility in Calgary on oil shales from Queensland, Australia, resulting in a pilot plant test program, was successfully completed in October, 1987. Approximately 1500 tonnes of oil shale were processed. This work was performed for, and jointly funded by, Southern Pacific Petroleums NL and Central Pacific Minerals NL who are planning to construct and operate a demonstration scale plant in Queensland embodying the AOSTRA Taciuk Processor technology for the recovery of liquid hydrocarbons from the oil shales of the Stuart deposit.

A letter of intent has been signed with UMATAC giving UMATAC the licensing rights to use the AOSTRA Taciuk Processor technology for hydrocarbon waste treatment applications. UMATAC is pursuing waste treatment opportunities in Canada and the U.S.A.

A test program for treating heavy oil production wastes from the Lloydminster and Cold Lake areas of Alberta using the AOSTRA Taciuk Processor technology has recently been completed at the Calgary pilot plant. This program was jointly funded by Environment Canada, Energy Mines and Resources Canada and AOSTRA. The program consisted of batch pyrolysis and combustion tests on a wide range of heavy oil production wastes followed by the processing of approximately 380 tonnes of heavy oil waste material in the 105 tonnes/day pilot plant. Preliminary analysis of test results indicate efficient recovery of the contained hydrocarbons and production of hydrocarbon-free spent solids which are environmentally acceptable for landfill.

6.2 Solv-Ex Solvent/Water Extraction Process Evaluation

AOSTRA, Shell Canada Limited and Solv-Ex Corporation have participated in a project to test the performance of the Solv-Ex Process for the extraction of bitumen from mined oil sands and to determine capital and operating costs for the construction and operation of a demonstration plant on Shell's surface mining lease in the Athabasca deposit.

The Solv-Ex Process is a development of the Solv-Ex Corporation of Albuquerque, New Mexico, and is essentially a solvent-assisted hot water extraction process. The feed oil sands is mixed with water and solvent in a staged counter-current process circuit. The process discharge streams are bitumen product and solids with the solvent being recovered for reuse.

The project consisted of two phases. Phase I, which cost $6 million, was funded by Shell and AOSTRA on a 50-50 basis and consisted of a test run program in a one tonne/hour pilot plant located in Albuquerque. The pilot plant testing was completed in February, 1987. Twelve hundred tonnes of oil sands feed material were shipped to Albuquerque from Shell's lease near Ft. McMurray, Alberta. Final reports for the Phase I work were received in December, 1987.

Phase II of this project consisted of the preparation of engineering designs and capital and operating cost estimates for a 1200 m^3/d stand-alone bitumen production plant to serve as a semi-commercial demonstration of the Solv-Ex Process. The Phase II engineering and cost estimates were prepared by Fluor Canada. The total cost of Phase II was $1.2 million of which 25% was paid by AOSTRA and 75% by Shell Canada. The Phase II final report was received in September, 1987.

AOSTRA staff are currently reviewing the final report and finalizing their evaluation of the process.

6.3 OSLO (Other Six Leases Operation) Dredge Mining and Cold Water Extraction Development Project

AOSTRA and the OSLO Group have funded the first year of a multi-year project, on a 50-50 basis, to evaluate the use of dredge mining and to develop a compatible cold water extraction process. The object of this approach is to reduce the overall cost of bitumen production from mined oil sands.

The overall study project is estimated to be a four year program which would cost approximately $31 million and would culminate in a field demonstration of a commercial sized dredge/extraction facility.

The first year (1987/1988) program, approved by AOSTRA and OSLO at a cost of $900,000, consisted of laboratory bitumen extraction testing; design, construction and operation of a laboratory sized pilot dredge; oil sands slurry pumping and dispersion tests and a feasibility study for field testing of the pilot dredge and the cold water process.

The experimental results to date are positive showing attractive bitumen recoveries in the laboratory extraction tests and physically illustrating the ability to dredge and extract bitumen in an integrated operation of the laboratory-sized pilot plant in Calgary.

The main activities planned for Year 2 (1988/1989) of this project will consist of ice melting tests to be carried out at Esso Resources' test basin in Calgary; continuation of laboratory scale extraction tests; transportation, set-up and field testing of the integrated dredging, pipelining, and extraction pilot plant at a location on lease #41 near Ft. McMurray; and a detailed engineering study and preparation of final cost estimates for a 600 tonne/hour field demonstration facility. The Year 2 costs are estimated to be $1.9 million of which AOSTRA has agreed to fund 50%.

6.4 Solvent Extraction - Spherical Agglomeration (SESA) Process

AOSTRA and the National Research Council (NRC) are participating with Terra Energy Ltd. in preparing a cost estimate for a demonstration plant to test the SESA solvent extraction process for the extraction of bitumen from mined Athabasca oil sands. The SESA process involves contacting mined oil sands with carefully controlled small amounts of water and a naphtha solvent in a rotating drum. The naphtha solvent extracts the bitumen while the water facilitates the agglomeration of the fine clay minerals with the sand particles. In a series of solids-liquid separating steps, a product consisting of bitumen dissolved in the naphtha solvent and a tailings of agglomerated solids wetted with the naphtha solvent are produced. The naphtha solvent is recovered from the bitumen by conventional refinery distillation and from the tailings by evaporation. Terra Energy holds the license with Canadian Patents and Development Ltd. (CPDL) to develop and operate a SESA demonstration plant. The SESA solvent extraction process has been developed and piloted on a laboratory scale by NRC.

Phase I of the project will cost $1.0 million and is being funded on a 50-50 basis by AOSTRA and NRC. This phase consists of the preparation of engineering designs and capital and operating cost estimates for the construction and operation of a 10 tonne per hour demonstration plant and a technical and economic evaluation of the SESA process compared to the conventional hot water extraction process.

The preliminary process criteria, material and energy balances have been completed. The engineering cost estimate and comparison study is being carried out by a Canadian engineering company, Kilborn Energy Inc. The final report is targeted to be completed by September 1988.

7 Upgrading Program

The major thrust of the Upgrading Program has continued to be the demonstration of improved upgrading technology. The major test programs described below were initiated in 1986/1987 and continued to completion in 1987/1988. This has resulted in significant advancements in upgrading technology increasing the options available as proven technology ready for commercial application.

7.1 Gulf Donor Refined Bitumen Project

In late 1986, AOSTRA funded a major demonstration test of the Gulf Donor Refined Bitumen (DRB) Process. This process for upgrading bitumen involves thermal cracking and liquid phase hydrogenation using a process derived hydrogen donor solvent. A sixty day test was carried out at the ASVAHL test refinery near Lyon, France. ASVAHL (Association pour la Valorisation des Huiles Lourde or the Association for

Heavy Oil Upgrading) was a partner in the demonstration along with Gulf Canada Resources Inc., Gulf Canada Limited and AOSTRA. AOSTRA provided $10.8 million for the demonstration test. The test was completed in December, 1986, and the final reports have now been received. The major conclusions are that the basic principles of the DRB Process has been confirmed but further work is required on equipment development. The yield of synthetic crude oil from Athabasca bitumen was 92 LV% and donor self sufficiency was demonstrated. At ASVAHL extended test runs were not possible due to solids accumulation (coke and clay) in the process reactors. Equipment modifications may be possible to correct this problem while maintaining the simplicity and economic advantages of the process.

An agreement has been negotiated between Gulf, AOSTRA and ASVAHL which sets the basis for future work.

7.2 High Conversion H-Oil Tests

Final reports have now been received on a demonstration test of the High Conversion H-Oil process done at the HRI pilot plant in January, 1987. This process is an extension of the commercially proven H-Oil ebullated bed hydrocracking process, the basis for the Husky Bi-provincial Upgrader Project. AOSTRA provided $1.7 million to sponsor this demonstration.

The test was very successful with all test objectives being met. Cold Lake feedstock was processed in an uninterrupted six week test run, with three weeks of operation at high conversion (92%).

Products from the primary conversion process were hydrotreated to determine the product quality which could be expected from a commercial facility. The yield of liquid products from such an upgrader would be 104 LV% while meeting synthetic crude specifications and minimizing residue production.

The test provides an excellent database for process design and guarantees for a commercial upgrading project.

7.3 VEBA Combi Cracking (VCC) Test

The VEBA Combi Cracking (VCC) Process is a high conversion hydrocracking process which combines thermal hydrocracking in a liquid phase reactor with catalytic hydrotreating in a gas phase reactor.

In May, 1987, a demonstration test of the VCC Process was undertaken with Cold Lake heavy oil at the VEBA OEL GmbH pilot plant in Gelsenkirchen, West Germany. AOSTRA provided $3.7 million or 80% of the cost of this project.

A successful continuous operation was demonstrated throughout the test period of almost 700 hours, with over 400 hours at the target conversions level of 94%. This would result in high quality synthetic crude being produced at a commercial upgrader at over 105 LV%.

A second test was undertaken in January, 1988, using Athabasca bitumen as the test feed. AOSTRA provided $1.5 million or 60% of the cost for this second test. The test was undertaken to determine the possible effect of clay in the feed on upgrader performance.

To provide the Athabasca feedstock, a trade was arranged between VEBA who had surplus Cold Lake crude and ASVAHL who had Athabasca bitumen remaining from the Gulf DRB test.

The test, in which 235 m^3 of Athabasca bitumen were processed, began on January 4, 1988, and again, was successful. The fine clay in the Athabasca feedstock had no apparent effect. Conversion levels of 94% were readily maintained at process conditions very similar to the previous Cold Lake test. The test continued smoothly, on specification, until the feed ran out on January 20.

Based on the success of the earlier tests, VEBA proposed a further high throughput scouting run utilizing the remaining Cold Lake feedstock at Gelsenkirchen. Rather than shutting down on January 20, the feed was switched from Athabasca to Cold Lake and the throughput raised by 50%. Following appropriate temperature adjustments, samples were obtained for one balance period at over 90% conversion before the pilot plant was shut down on January 24.

The series of successful demonstration tests provides an excellent design database and increased confidence that the VCC Process is ready for commercial application for heavy oil upgrading in Alberta. Cost estimates and economics based on the test data have confirmed the high ranking of VCC among upgrading processes.

7.4 Upgrading Residue Utilization Project

A key factor in upgrading economics is the utilization of any residues produced by primary upgrading processes. The form, quantity and quality of these residues (pitch or coke) can affect the cost and complexity of the overall upgrading plant. AOSTRA, the Federal Department of Energy, Mines and Resources and eight industrial participants commissioned a study which identified combustion as the most promising method of economically using most upgrading residues. Combustion is difficult with these materials because of the low volatility and high melting point of the residues. Sulphur and metals such as vanadium can also cause corrosion and environmental emission problems.

In the past year AOSTRA and the participants have carried out a small scale program at a cost of $260,000 to acquire various representative upgrading residues, to determine key chemical and physical properties and to undertake preliminary combustion tests.

Residue quantities sufficient for combustion tests (1 tonne minimum) have been acquired for the following processes: CANMET, DRB, EUREKA, H-OIL and COMBI-CRACKING. The analytical program at the Alberta Research Council is now complete and tests to determine combustion and heat transfer characteristics of residual fuels have been initiated at the EMR CANMET Combustion and Carbonization Research Laboratories (CCRL) near Ottawa. Test runs in the 2 GJ/h tunnel furnace have been successfully

completed for three of the five residues. Further tests at CCRL and other facilities are expected to be completed by mid-1988.

7.5 Oil Sands Task Force

In the fall of 1987 AOSTRA joined with the Alberta Chamber of Resources' Oil Sands Task Force (OSTF) in a study to evaluate the concept of a small-scale regional upgrader (4700 m^3/cd) which would accept bitumen feedstocks from satellite surface mining/extraction plants, or in situ production facilities, or both. The concept was seen as a possible alternative to fully integrated synthetic crude oil plants and as a method of promoting and maintaining oil sands and heavy oil development in the province. The concept would offer benefits through separate ownership of production and upgrading facilities; expand resource development by providing an outlet for production from smaller leaseholders; and improve economics through accelerated plant start up and cash flows due to the smaller project size.

In December, 1987, the OSTF issued a final report to the Minister of Energy detailing the costs, opportunities and benefits of the regional upgrader concept. The study concluded that synthetic crude could be delivered to Edmonton at a cost as low as C$29.00/BBL. In strict economic terms the concept was not viable at current oil prices, however, measured in terms of social benefits, i.e. direct and indirect employment, the concept offered returns to Alberta and Canada.

With the completion of the study, activities are now being directed towards increasing industry and government awareness of the opportunities for oil sands development, through informal discussions and seminar presentations. In addition, the OSTF is planning to develop a business plan based on the regional upgrader concept. This should be completed by the end of 1988.

7.6 Oil Sands Coke Desulfurization Project

The completed project reports prepared by the Nova Husky Research Corporation on the "Desulfurization of Coke Generated from the Direct Coking of Oil Sands" were received in December 1987. The project, which grew out of a previous study, was initiated in early 1986 to test the benefits of the addition of various calcium compounds to the direct coking process. The effect of calcium addition on the flue gas sulfur content was measured for calcium injection at various locations within the process. It was found that calcium addition was effective in suppressing flue gas sulfur if the operating conditions were carefully controlled.

Several Alberta limestones were characterized for their reactivity over a large temperature range and process conditions were altered to provide an opportunity for the calcium to perform at peak efficiency. The $176,000 project was sponsored by AOSTRA (95%) and Canstar Oil Sands Ltd. (5%) over a two year period.

No further research with the Nova Husky Research Corporation is planned at this time.

8 Environmental Activities

AOSTRA's mandate includes the stipulation that the technology developed must ensure acceptable environmental standards during and after oil sands and heavy oil operations. While the main driving force for AOSTRA's activities is the development of economically attractive technologies to enhance the production of oil sands bitumen and heavy oil in Alberta, the choice of specific processes for development is based in large part on their capability of preserving a quality environment. AOSTRA's interests focus on: reduction of fresh water consumption at in situ recovery operations; elimination or reduction of extraction process tailings ponds; minimizing the production of upgrading residues and utilization of those upgrading residues in an environmently acceptable manner; disposal of hydrocarbon-bearing wastes; monitoring and control of process effluents and air emissions; health and safety standards; and reduction of land disturbance in drilling programs. Some of these activities are described below:

Elimination or Reduction of Tailings Ponds can be accomplished through the use of alternative extraction processes which do not produce the stable clay/water dispersions of the conventional hot water process. AOSTRA has been involved with three such processes during the past year.

The AOSTRA Taciuk Direct Thermal Processor, conceived as a method for the simultaneous extraction and primary upgrading of bitumen from mined oil sands, produces hydrocarbon-free, dry tailings as the major by-product. In terms of its environmental impact, the Processor represents a major improvement over conventional bitumen extraction technologies since it eliminates tailings ponds.

Oil Sands Coke Desulfurization is applicable to sulfur capture in the operation of a dry retorting process for the simultaneous extraction and primary upgrading of oil sands bitumen, such as the AOSTRA Taciuk Direct Thermal Processor.

The Solv-Ex Process is a solvent-assisted hot water process. The developers of the process claim that a major environmental advantage of the Solv-Ex Process is the production of damp sand tailings and reusable water. One of the reasons for AOSTRA's interest in testing this process arose from its potential to eliminate the tailings ponds created by the existing hot water extraction process.

The SESA Process is a solvent extraction/spherical agglomeration process which uses a controlled amount of water with solvent to promote agglomeration of the fine particles. The major waste stream is composed of dried agglomerates, containing a small percentage of unrecovered hydrocarbon. Like the Solv-Ex Process, the SESA Process offers the possibility of disposing of the solids discharged from the process without the need for tailings ponds.

Minimizing the Production of Upgrading Residues can be accomplished most effectively by the adoption of hydrogen addition upgrading processes in place of carbon rejection processes. Coking processes presently used in commercial bitumen upgrading operations in Alberta produce relatively large quantities of coke residue which is not used in the process and is therefore stockpiled as a waste by-product. In 1980, AOSTRA initiated a joint AOSTRA/industry evaluation of new upgrading processes which offered the possibility of higher conversion of bitumen to lighter oils suitable for inclusion in synthetic crude oil. A corollary of higher bitumen conversion is a corresponding reduction in the amount of residue produced in the primary upgrader. The evaluation identified several high conversion processes, based on the addition of hydrogen to bitumen in high pressure reactors, which would not only improve overall project economics, but would also sharply reduce the quantity of residue.

Two of the highest ranking processes, HRI's High Conversion H-Oil and VEBA OEL's Combi-Cracking, were subsequently demonstrated successfully with Alberta feedstocks in existing large scale experimental plants. These AOSTRA funded tests paved the way for potential commercial use of such processes in Alberta, with their attendant reduction in the quantity of residue formed.

The Upgrading Residue Utilization Project was initiated in 1982 as a joint AOSTRA/industry project following the upgrading process study. The ultimate use or method of disposal of the upgrading residues (pitches and cokes) has a significant effect on the relative economics of the different processes, and AOSTRA is strongly interested in evaluating and ultimately testing methods by which upgrader residues might be beneficially utilized in an environmentally acceptable manner.

The conclusions of the comparative study pointed to residue combustion for steam generation as the most economic method for disposal. In a subsequent phase, AOSTRA and its industry partners are conducting a program of residue analyses and preliminary burning tests to assess the combustion characteristics of representative residues.

The Treatment of Hydrocarbon-Bearing Wastes using the AOSTRA Taciuk Processor is a recent alternative in the Processor's development. The Processor has been demonstrated as an effective means for treating oil contaminated soils to yield oil-free solids suitable for landfill and an oil product which may be refined in conventional refining processes.

Interest has been shown by many companies in the use of the Processor to treat both hydrocarbon-bearing waste and other environmentally unacceptable wastes from contaminated sites. Of particular interest is the use of the Processor to separate polychlorinated biphenyls (PCB's) from soils which have become contaminated by spillage. Preliminary pilot tests have demonstrated excellent recovery of separated PCB's.

The Underground Test Facility provides a shaft and tunnel access (SATAC) method for the underground thermal in situ recovery of bitumen from oil sands. The concept permits the use of closely-spaced horizontal wells in in situ recovery operations with minimum disruption of the environment.

The Syncrude Air Quality Prediction System was developed in conjunction with AOSTRA to allow for the prediction of favorable conditions under which plant emissions could be released while conforming to the environmental regulations. The air quality prediction system allows the plant operator to forecast local weather conditions and to predict the plume "footprint" and maximum sulfur dioxide emission for a range of possible emission rates. Thus the operator can judge which strategy best meets Syncrude's multiple objectives of safe, reliable plant operation and maximum production with the least environmental impact. The air quality prediction system uses continuous stack emission monitoring, a meteorological monitoring network, an air monitoring network (AMN), a central forecasting facility and a man/machine interface for prediction/decision making.

Genotoxicity Testing of Process Streams and Production Fluids was supported by AOSTRA and performed by the British Columbia Cancer Foundation. The objective of the program was to develop a test method for making human carcinogen risk assessments for the process streams found in oil sands recovery operations. The test utilized freshly isolated intestinal mucosa in genotoxicity testing of process streams. The procedure was evaluated against the use of established mammalian cell cultures.

Produced Water Treatment for Steam Generation is of interest to AOSTRA as a means of reducing fresh water make-up requirements and brackish water disposal problems at in situ operations. The AOSTRA/Industry Produced Water Treatment Study and the studies reported in section 5 with Shell Canada Resources Ltd. and with Environment Canada/ Industry are examples of projects designed to protect Alberta's water resource.

While not identified as separate projects, AOSTRA has engaged in other endeavors which have reduced the environmental impact of the oil sands industry. These include the use of directional drilling from central pads, for example in the Shell Peace River and BP/Petro-Canada Wolf Lake in situ operations, the ongoing sulfation monitoring at in situ pilot operations, the ground water studies prepared for pilot operations and the use of environmental consultants to ensure that operations comply with environmental regulations.

9 University Program

9.1 Senior Research Fellowships

In 1987, AOSTRA announced the establishment of the AOSTRA Senior Research Fellowship program. The program is intended to encourage outstanding individuals to develop research activities relevant to AOSTRA's mandate and to encourage technology transfer by promoting

personal contact and involvement with other institutions. The Fellowships will be available to tenured faculty members in science and engineering and to established researchers in industrial research organizations. They may be held at recognized universities or industrial research establishments for various periods not exceeding three years. Either the host institution or the Fellow's institution must be located in Alberta. Fellows will be expected to devote themselves to research and/or other activities of direct interest to AOSTRA and will be eligible for research funds through other AOSTRA programs.

9.2 Professorships

This year marks the conclusion of the AOSTRA Professorship Program as currently structured. Over the past twelve years, eleven professors have been appointed to Professorships at Alberta universities to carry out advanced research on oil sands problems. The initial appointment of three years, was renewable for a further term of two years. The current incumbents are involved in the following research projects:

1. Dr. J.W. Costerton of the University of Calgary (AOSTRA Professor, 1985 - 1987) is investigating the use of bacterial ultramicrocells as a method of preventing coning and controlling fluids flow in high permeability zones in conventional and heavy oil reservoirs.

2. Dr. L.G. Hepler of the University of Alberta (AOSTRA Professor, 1978 - 1987) has been continuing his investigation of clay/oil/water systems encountered in many aspects of the oil sands industry and is also measuring specific heats of various components of oil sands and heavy oil deposits.

3. Dr. O.P. Strausz of the University of Alberta (AOSTRA Professor, 1981 - 1987) has been continuing the investigation of the chemistry of Alberta oil sands bitumens, with particular emphasis on the heavier fractions.

4. Dr. E.L. Tollefson of the University of Calgary (AOSTRA Professor, 1982 - 1987) has been continuing the investigation of desulfurization of coke and the relative fuel values of some constituents of oil sands.

These professors devote approximately three-fourths of their time to oil sands research. The total funding for the Professorship program has been $4.0 million, over a 12 year period.

The program has been extremely successful in establishing oil sands research in Alberta universities. The new Senior Research Fellowship Program will expand these opportunities to include industrial research laboratories and will also encourage more active university/industry technology transfer and collaboration.

9.3 Lectureships

The new AOSTRA Lectureship Program was announced this year. The program will fund experts from Canada and abroad to travel to Alberta to present seminars or courses to industry and to the research community in areas relevant to AOSTRA's mandate.

9.4 Graduate Scholarships and Fellowships

Post-graduate scholarships and fellowships have been made available over an eleven-year period for oil sands research at the University of Alberta, the University of Calgary, and the University of Lethbridge. Current award holders are identified in the following lists. The scholarships are for a maximum period of two years and the research carried out will normally lead to either a Masters or Doctoral degree. Fellowships are intended to assist post-doctoral scientists in furthering their research training. Many of these individuals will eventually enter the industrial research sphere.

University of Alberta

Bell, D.D.	Mattison, B.W.
Chalaturnyk, R.	McKay, G.J.
Cloutis, E.	Natchel, M.
Eastwood, J.	Roberts, D.
* Foght, J.M.	Sarma, H.K.
Khorashek, F.	Steer, J.G.
* Lappin-Scott, H.	Tsingas, C.
Le, L.	Zelt, B.W.

University of Calgary

Chang, K.	Monnery, W.D.
Chung, K.	Nighswander, J.A.
Eastick, R.	Senqupta, S.
Kirk, M.J.	Sim, K.L.
Lewis, J.M.	Wassmuth, F.
Mehta, S.A	Wozniak, W.

* Fellowship

9.5 University Research Program

AOSTRA continues to support a wide range of oil sands and heavy oil related research projects at Canadian universities. The university research program covers many areas of practical interest ranging from fundamental research to new process development for the recovery and upgrading of bitumen and heavy oil. The budget in 1987/88 for support of research in Canadian universities amounted to approximately $2.7 million. Brief descriptions of the projects carried out in 1987/88 follow.

1. Dr. D.W. Bennion and Dr. R.G. Moore of the University of Calgary are continuing their extensive investigation of combustion in oil sands and the low temperature oxidation of bitumen. These researchers have been funded over the past 12 years for a total of $2,033,764.

2. Dr. P.M. Boorman, Dr. R.A. Kydd, and Dr. T.S. Sorenson of the University of Calgary are developing hydrocracking catalysts capable of being used under mild conditions to enhance the yield of liquid products with low aromaticity. This work and earlier studies by Dr. Boorman have been funded at $619,971 since 1976.

3. Dr. B.D. Bowen and Dr. S. Levine of the University of British Columbia have been using theory and experiment to identify the mechanisms by which fine particles and clays stabilize emulsions. This project has been funded in the amount of $312,416 over 5 years.

4. Dr. R.M. Butler of the University of Calgary is investigating heat and mass transfer mechanisms important to processes for in situ recovery of bitumen. Funding of Dr. Butler's work amounts to $582,500 over four years.

5. Dr. R.G. Cavell of the University of Alberta is applying Secondary Ion Mass

Spectrometry (SIMS) to study the interaction of polar organic and inorganic molecules with mineral surfaces such as those found in tailings of the hot-water process. The amount of funding is $151,410 for a three-year period.

6. Dr. F.S. Chute and Dr. F.E Vermeulen of the University of Alberta have been measuring electrical properties of oil sands, developing physical models of electrical heating processes, and evaluating the use of electrical power for selective heating of oil sands. Their research has been funded in the amount of $837,633 over a period of twelve years.

7. Dr. J.W. Costerton of the University of Calgary is investigating the use of bacteria as injection agents to prevent coning and to improve conformance by selectively plugging high permeability zones. A total of $442,000 has been allotted to this and earlier projects over five years.

8. Dr. J.E. Desnoyers of the Universite' du Que'bec completed a study of phase equilibria and other properties of oil-water micro-emulsions, with the objective of using microemulsions for the extraction of bitumen and heavy oil. Funding for this work amounts to $397,280 over seven years.

9. Dr. M.B. Dusseault of the University of Waterloo continued a project to delineate the volume and permeability changes that occur under the low shear stress conditions that accompany high pressure injection during in situ recovery. He also began a new project to obtain geotechnical data needed to assess novel technological approaches to overburden and tailings waste management in mining operations. Funding of these studies and previous geotechnical work by Dr. Dusseault amounts to $494,757 over twelve years.

10. Dr. S.M. Farouq Ali of the University of Alberta is studying the use of small amounts of carbon dioxide gas to improve the water-flooding process for recovery of Alberta light oils, developing new methods of mobility control that will improve recovery of heavy oil or bitumen from the Athabasca and Lloydminster deposits and constructing a computer program to model formation fracturing and recovery during steam-injection operations. Funding of these projects amounts to $1,683,068 over ten years.

11. Dr. M.R. Gray of the University of Alberta is developing methods to characterize the kinetics of refining processes in terms of the functional groups of the components of bitumen feedstock. This project, and earlier work with Dr. I.G. Dalla Lana have been funded in the amount of $350,000.

12. Dr. L.G. Hepler of the University of Alberta is investigating the colloidal properties of various clay/oil/water systems, primarily for application to water and tailings treatment. He is also measuring the thermodynamic properties of bitumen/gas systems and the kinetics of bitumen oxidation, to obtain quantitative relationships useful in modelling in situ recovery processes. Funding has amounted to $966,988 over ten years.

13. Dr. T.R. Hsu of the University of Manitoba is developing a computer program to model high-velocity fracturing of oil sands for application to processes used to generate interwell communi-cation paths. Laboratory experiments are underway to test and refine the program code. This four-year project costs $316,300.

14. Dr. I.E. Hutcheon of the University of Calgary is conducting laboratory work and field studies to characterize the dissolution and precipitation of minerals in thermal processes for recovery of bitumen. Funding of this eight-year project amounts to $782,290.

15. Dr. J.B. Hyne and Dr. P.D. Clark of the University of Calgary are studying the chemical reactions in bitumen that cause gas to be produced as a reservoir is steamed, and their effects on the physical properties of the bitumen. The cost of this project and earlier work by Dr. Hyne is $537,505.

16. Dr. F.W. Jones and Dr. J.S. Rogers of the University of Alberta are developing an improved meter to measure tilt of the surface induced by a recovery process. This instrument is potentially useful for monitoring the progress of in situ recovery processes and is being tested at the GLISP site. This seven-year project cost $382,348.

17. Dr. G. Karim of the University of Calgary is investigating the processes of ignition, flame propagation, and quenching in low velocity streams of fuel in vapor-air mixtures in porous media. This three-year project and earlier work were funded at $156,920.

18. Dr. B.C.-Y. Lu of the University of Ottawa is conducting laboratory experiments to measure phase equilibria of mixtures of water and bitumen under the conditions obtained in steam processes. Also, Dr. Lu is examining the internal consistency of existing data on gas solubilities in bitumen which are available to AOSTRA. Funding amounts to $177,160 over five years.

19. Dr. J. Masliyah and Dr. K. Nandakumar are studying the hydrodynamics of gravity separation processes involving suspensions of light and heavy particles. Dr. Masliyah is also investigating the use of flotation columns as an alternative to traditional flotation cells for the recovery of bitumen. Total funding for these two projects is $250,720.

20. Dr. A.K. Mehrotra and N.E. Kalogerakis of the University of Calgary are attempting to measure and model the distribution of carbon dioxide between oil and brine under in situ recovery conditions. $302,923 has been allotted to this and earlier projects over an eight year period.

21. Dr. N.R. Morgenstern and Dr. J.D. Scott of the University of Alberta are measuring the strength, deformability, and perme-ability of oil sands at the high temperatures and pressures that are found in in situ thermal processes. The objective is to develop a geomechanical model for reservoir assessment. This work and earlier studies by these researchers have been funded to a total of $1,064,209 over a ten-year period.

22. Dr. E. Nyland and Dr. E. Kanasewich of the University of Alberta are developing and testing algorithms that interpret signals received by geophones to monitor and locate sources of

microseisms induced by in situ processes. Total funding of $896,864 has been allocated for this and earlier work, over an eight-year period.

23. Dr. S.G. Pemberton of the University of Alberta is studying the ichnological microdynamics of the Athabasca oil sands. Traces of the fossil workings of worms provide good paleontological control and facies predictive capabilities beyond the borehole. Funding for this five-year project and related work is $436,265.

24. Dr. D.Y. Peng of the University of Saskatchewan is analyzing the application of continuous thermodynamics to develop improved equations of state for bitumen/gas systems. A total of $28,960 is budgeted for one year.

25. Dr. R. Puttagunta of Lakehead University is developing general correlations to predict the viscosity of bitumen gas mixtures in all Alberta oil sands formations under in situ recovery conditions. The project is funded at $40,000 over a two-year period.

26. Dr. C. Scarfe of the University of Alberta is measuring the dissolution kinetics of calcite and dolomite under in situ recovery conditions, for application to modeling reservoir fluid chemistry. $94,095 is budgeted over three years.

27. Dr. J.D. Scott, Dr. N. Kerr and Ms. E.A. Richards are investigating the use of geotextile filters in sand control. The cost of this exploratory project is $36,256.

28. Dr. F. Seyer of the University of Alberta completed a project to analyze the effect of mass transport phenomena in the hot water recovery process. This one-year project is budgeted at $30,560.

29. Dr. T.J.T. Spanos of the University of Alberta is developing mathematical expressions that describe the flow of mixtures of oil and water through sand, the gravity drainage process, and the propagation of sound through an oil sands deposit. This research cost $354,383 over seven years.

30. Dr. O.P. Strausz and Dr. D.S. Montgomery of the University of Alberta have been conducting several continuing in-depth research projects to characterize different aspects of the chemistry of bitumen. These involve: the identification and quantification of compound types and geochemical markers, studies on the chemical and thermal degradation of asphaltenes and resins, and the influence of various catalysts on these processes, identification of the causes of poor separability of some bitumens, and the design of new upgrading technology. Total funds spent and committed in the period 1977 to 1989 amount to $2,948,199.

31. Dr. W.Y. Svrcek and Dr. A.K. Mehrotra of the University of Calgary have directed a series of projects to measure the solubilities of gases in bitumen and the viscosities of the resulting gas-bitumen solutions. Total funding since 1976 has been $398,830.

32. Dr. T.W. Swaddle of the University of Calgary is using nuclear magnetic resonance techniques to identify the dissolved silicate and aluminosilicate species that form under conditions in which formation minerals dissolve and precipitate during in situ recovery. Funding of $50,322 was allotted to this one-year project.

33. Dr. E.L. Tollefson of the University of Calgary is investigating the technology of upgrading coke, pitch, heavy oil, and bitumen. This work and earlier studies on methods of coke desulfurization have been funded at a level of $778,370 over ten years.

34. Dr. J.K.S. Wan of Queen's University is investigating the use of microwave heating of dilute catalysts to hydrocrack fractions of bitumen. Also, Dr. Wan is improving his similar process developed earlier for AOSTRA to generate olefins from methane and other alkanes. Total funding is $568,264 for eight years.

35. Dr. N.C. Wardlaw of the University of Calgary is investigating rock-pore properties in carbonate and sandstone reservoirs important to enhanced oil recovery processes. This project and earlier work has been funded at $537,384 over a six-year period.

The AOSTRA University/Industry Access Program provides industry with ongoing research reports, regular interactions with researchers, non-exclusive technology use rights, and an opportunity to participate in project evaluation. An Associate Membership category allows companies to obtain membership privileges with somewhat restricted participation in project evaluation and technology use rights. In 1987/88, eleven companies participated in the program as full or associate members at annual fees of $50,000 or $10,000, respectively.

10 AOSTRA–Alberta Research Council Program

AOSTRA continues to support several major research programs at the Alberta Research Council (ARC). These programs can be classified into two main categories: "Core Research" and "Strategic Research".

10.1 Core Research Program

The Core Research Program focuses mainly on the regional and generic problems which are common to much of the industry, and include:

- evaluation and verification of new and novel concepts
- investigation of fundamental recovery (both in situ and surface) and reaction (extraction and upgrading) mechanisms
- determination of essential physical and chemical properties
- support of long and medium term technology development

The Core Research projects are currently funded jointly with ARC and, in some cases, another government agency. Three major areas are included in the Core Research Program:

1. Oil Sands and Hydrocarbon Recovery Research: This program is funded by AOSTRA and ARC on a 50/50 basis. In 1987/88 fiscal year, approximately $3 million was expended. As currently structured, it consists of six projects meeting the following needs:

- to obtain a quantitative description of the fundamental mechanisms which control and characterize fluid flow in elements of the reservoir. The understanding of flow mechanisms in a reservoir will ultimately improve and enhance the recovery efficiency
- to develop procedures and processes which enable control of flow patterns in heterogeneous reservoirs
- to develop advanced steam based recovery processes which would have application in field pilot trials
- to obtain a quantitative description of the geochemical reactions occurring in the reservoir in the near well regions and to develop remedial procedures which would resolve the deterious effects of such reactions
- to develop necessary advanced correlations of reservoir engineering parameters
- to continue development of advanced tools in the forms of software and hardware to support other program needs.

The transfer of technology from this program is via the Access Program through which companies can obtain the technical information generated from the program by paying the annual membership fee, which currently amounts to $60,000. This year AOSTRA and ARC have set up a technical committee and project subcommittees for the Core Research Program, with representation from the Industry Access Program members, to provide direction and increased interaction with industry.

2. Regional Geology Studies: This program is supported on an equal, tripartite basis by AOSTRA, ARC and the Alberta Department of Energy, with each agency contributing $400,000 per annum. To capitalize upon the existing geological expertise and data base, the program is focusing on resource characterization and detailed geological reservoir studies.

Under this program, geologists have identified and mapped three different types of sand bodies and their variations in Athabasca Central, which will influence eventual recovery processes. In some parts of the Bodo pool, rich reservoir horizons are interrupted by shale layers. A multidisciplinary group is developing a method for predicting the effect of these shale layers on oil recovery. These models will have applications to other types of geological structures.

The technical information generated from the program is also made available to the industry through the Access Program.

3. Hydrocarbon Processing and Upgrading Project: In 1984, AOSTRA and ARC agreed to a three year joint Hydrocarbon Upgrading Program to develop the skills needed to do research significant to the Province's current interest in upgrading of bitumen. The initial three year effort, in the development of technology and expertise, resulted in the establishment of a specialized laboratory in the province for research in hydrocarbon upgrading with professional and support staff trained to do research and process development. A new five-year arrangement between AOSTRA and ARC commenced immediately after the previous three-year joint program expired on March 31, 1987. Under the new agreement, three new projects were jointly developed by AOSTRA and ARC staff:

- Pitch Conversion – to study the effects of novel catalysts, developed by AOSTRA's University Research Program, on conversion by hydrocracking and by catalytic hydrogenation of pitch and atmospheric residues
- Mechanisms of Coke Formation – to obtain an accurate description of how residues of bitumen thermally degrade to form coke. Flow of the fluids over various surfaces, some heated, is studied to determine parameters important to the design of cokers and other hydroprocessing equipment
- Novel Concepts in Hydroprocessing – novel concepts arising from AOSTRA's University Research Program are being tested for bitumen hydrotreating at near-ambient temperatures and pressures.

10.2 Strategic Research Program

In contrast to the "Core Research Program", the "Strategic Research Program" is designed to provide a confidential forum within which applied proprietary research and development can be undertaken to meet AOSTRA's specific needs in all areas of operation. The "Strategic Research Program" has three broad objectives:

- to take concepts, data and insights gained from the laboratory, and apply this knowledge to individual field situations;
- to address specific problems that arise in the course of field operations; and
- to investigate and evaluate results of the above in terms of potential broader application to resource development.

The program is funded 100% by AOSTRA and conforms to AOSTRA's priorities which are continually monitored by the Program Committee, so that the projects can be appropriately modified from time to time. Approximately $1.7 million was expended in the 1987/88 fiscal year. Currently, the program consists of the following major areas of activity:

- water coning suppression
- horizontal well related technology which applies to the UTF project and other reservoirs
- development of processes which are applicable to deep Athabasca reservoirs
- microbial application to reservoir conformance control
- improvement of bitumen recovery efficiency for the hot water extraction process
- study of solvents suitable for extraction of bitumen from mined oil sand as an alternative to the hot water process to minimize environmental impact.
- artificial lift production research to improve the pumping efficiency for heavy oil production
- specific geological concerns of AOSTRA in areas of resource evaluation, pilot siting and process reservoir compatibility

- study of gas holdup in a bubble-slurry reactor in relation to hydrocracking processes for bitumen upgrading.

10.3 Sample Bank

In addition to the *Core Research* and *Strategic Research* Programs indicated above, AOSTRA also continues to support the Sample Bank project at ARC with a 2.4 person-year effort each year. The prime function of the Sample Bank is to provide "standard" oil sands, bitumen and other related samples to research workers around the world. In the year ending March 31, 1988, 86 shipments were made. A total of 25,156 kg were shipped generating $22,897 in income. The net operating cost of the Sample Bank was approximately $150,000 in the fiscal year 1987/88.

11 Programs at Other Research Organizations

11.1 Computer Modeling Group

AOSTRA and the Computer Modeling Group (CMG) entered into a five-year agreement on April 1, 1986 to develop advanced numerical simulators to meet AOSTRA's technical needs. Initially, CMG was requested to develop two advanced thermal simulators, namely:

- Thermal Wellbore Simulator (THEWS)
- Steam-Additive Reservoir Simulator (STARS)

The basic developmental versions of these two simulators have been completed and are subject to further validation and enhancement in future years as an ongoing activity. In 1987/88, AOSTRA supported CMG to the extent of $220,000 which is equivalent to two person-years of effort for developing these two simulators and providing thermal simulation support to AOSTRA staff. AOSTRA obtains access to and royalty-free use of all CMG models while development is in progress, and ongoing use of models to which it has made major financial contributions.

11.2 Petroleum Recovery Institute

AOSTRA continued to support the research program at PRI by matching industry membership contributions to a maximum of $700,000 during the 1987/88 fiscal year.

In the area of enhanced oil recovery technology, there are four major areas of research currently underway at PRI. The research areas are gas flooding, sweep efficiency, heavy oil and chemical flooding. Industry as well as AOSTRA has access to results of this work which are available for potential application. In addition, PRI supplies technical expertise to AOSTRA in the analysis of the performance of AOSTRA projects.

12 International Programs

AOSTRA continues to be active with a number of countries around the world. These contacts with other countries having a mutual interest in hydrocarbon recovery and processing lead to joint projects, technology exchanges, and technology sales. In addition, AOSTRA, with its large technology base and pool of technical specialists, has a unique opportunity to make foreign experts aware of Canadian technology and services and introduce Canadian companies to potential foreign markets.

During 1987 the following contacts were most active:

China

AOSTRA continues to conduct 6 joint projects with Research Institute of Petroleum Exploration and Development (RIPED) which is the central research institute for the Chinese petroleum industry. Under these projects, research work has been conducted in China and Canada and specialists have been exchanged between the two countries for up to a year. RIPED and AOSTRA jointly organized a Heavy Oil Symposium which was held in China in November, 1987. Twenty-seven Canadian papers and 23 from China were presented. AOSTRA continues to further its relationship with China and is negotiating joint projects with several oil fields as well as continuing its association with RIPED.

Soviet Union

In October 1987 AOSTRA visited the Soviet Union and concluded a memorandum of cooperation with the central committee for science and technology. Initial activities under this memorandum will likely involve the exchange of specialists for two to three month periods.

Hungary

Under terms of an exchange memorandum with the Hungarian Hydrocarbon Research Institute, an exchange of technical experts for a six month period has been arranged.

Czechoslovakia

During 1987, AOSTRA initiated a technology exchange agreement with Czechoslovakia. Signing of this agreement and initiation of activities will take place in 1988.

Romania

For several years, AOSTRA has conducted a number of technical exchanges with Romania. These programs are continuing and will lead to signing of a new memorandum in 1988.

Jordan

AOSTRA, working with Petro Canada International, has assisted Jordan in the evaluation of heavy oil and oil sand deposits.

Venezuela

AOSTRA has maintained active cooperation with Venezuela, which has some of the largest heavy oil and oil sand deposits in the world. As a result of a recent visit by the Minister of Energy for Venezuela to Alberta, and by AOSTRA personnel to Venezuela, a new cooperative agreement has been drafted and a number of areas of further cooperation explored.

Brazil

AOSTRA continues to work with Petrobras on use of the AOSTRA Taciuk Processor for the processing of Brazilian oil shale fines and filter cake. During the

year AOSTRA conducted bench scale tests on samples of these materials with very promising results.

U.S.A.

AOSTRA continues to work with Energy Mines and Resources Canada and the Saskatchewan Department of Energy and Mines under a cooperative memorandum of understanding with the United States Department of Energy. Joint projects in resource characterization, the use of additives with steam, and information exchange were carried out.

AOSTRA/UNITAR-UNDP Relationship

AOSTRA continues to actively support the UNITAR/UNDP Information Centre for Heavy Crude and Tar Sands. AOSTRA is cosponsoring and providing major support to the 4th International Conference on Heavy Crude and Tar Sands to be held in Edmonton, Alberta on August 7-12, 1988.

13 Training Programs

Regretfully, due to budget constraints AOSTRA was forced to suspend its summer student program for university students during 1987. It did, however, provide year-round employment for up to six co-op students, with each individual staying for a four or eight month period.

14 Industrial Post-Doctoral Fellowship Program

In 1983, AOSTRA initiated its industrial Post-Doctoral Fellowship Program which was designed to assist the transition of post-doctoral researchers from an academic to an industrial environment. During the two-year term of the award, valued at $22,500 per year, the AOSTRA Industrial Fellow conducts a research project in the laboratory of the sponsoring company which provides the space, equipment, and support personnel required for the proper conduct of the research.

Currently there are two holders of the award. Dr. Hans Vaziri is studying the response of oil sands masses to the boundary conditions that may be imposed during the oil recovery process. The work is underway at the laboratory of Golder Associates Consulting Geotechnical and Mining Engineers in Calgary.

Dr. Keng Haut Chung is studying the use of membranes for the clarification of recycle water from oil sands mining operations. This work is being conducted at the Syncrude Canada Ltd. Research Laboratory in Edmonton, Alberta.

15 Inventors Grant Assistance Program

The Inventors Grant Assistance Program (IGAP), first implemented in 1983, was continued during fiscal 1987. The purpose of IGAP is to encourage and assist inventors to develop inventions beyond the idea and concept stage so that conventional funding for commercialization may be obtained. Amounts to a maximum of $50,000 may be awarded to individuals or companies for use in developing inventions. AOSTRA does not earn any use rights to the inventions and the only requirement on the part of the inventor is a commitment to use the funds in the development of the invention and to supply both accounting and technical reports to AOSTRA.

This continues to be popular program with a total of 30 applications being reviewed during the year. Eight of these applications were approved for funding as follows:

IGAP Recipient	Amount of Grant	Activity Supported
E. Randle Abernethy	$30,000	For development of an ultrasonic depth sounder to gauge and record fluid levels in wells
Anderson and Associates	$40,000	To develop an instrument for measuring the water cut at various levels in a heavy oil heater treater
G.T. Boser and T.H. Brown	$ 2,240	To develop an acoustic device for measurement of fluid level and density in a wellbore
Wayne King Sand Control Systems	$50,000	To build a prototype and test a device for clean out of sand from production tankage
Ram Drilling Tools	$25,000	To assist in the construction and testing of a down hole device for blow out prevention
MBA H_2S Controls Ltd.	$10,000	To assist in the development of a unit for testing the level of H_2S scavenger in drilling fluids
Anderson and Associates	$49,135	For development of an improved sand exclusion liner
Anderson and Associates	$30,000	For development of an improved "jar" for use in highly deviated and horizontal wells

Grants awarded under IGAP have totalled $865,415 since the program was implemented.

16 AOSTRA Technology Transfer and Commercialization

AOSTRA technology is available on reasonable business terms and conditions to those parties wishing to gain access or license use of the technology.

In order to facilitate awareness of AOSTRA technology, a technology "sale" was held at the Calgary Convention Centre in March, 1988. Interested parties reviewed selected AOSTRA technology under terms of confidentiality in order to make a decision with regard to gaining access.

A comprehensive Catalogue of Technology reports, packages and programs was completed in March 1988 and distributed at the Technology Transfer Sale. The catalogue also includes a price list of reports and is available upon request from the Manager, Technology Transfer and Commercialization.

The technology available from AOSTRA is categorized as follows:

16.1 Completed Projects

A completed AOSTRA project is indexed and catalogued for future reference. The technical information that has been developed from the project is prepared into component packages for technology transfer to eventual users. AOSTRA technology is priced in accordance with its usefulness to the user, subject to negotiation between the purchaser and AOSTRA and its partners. Should an agreement not be reached, a fair market value may be established through arbitration.

16.2 Active Projects

One method of obtaining current technology on an ongoing basis is by joining an operating project as an active participant. By investing 12.5% or more equity into a project an active participant will realize voting rights and a world wide license fee-free right to use the technology. Investors of less than 12.5% are referred to as consultive participants and they enjoy technology use rights but not voting privileges.

16.2.1 University Research Projects

The university research program covers many areas of practical interest ranging from fundamental research to new process development for the recovery and upgrading of bitumen and heavy oil. A total of eleven companies and research institutes have accessed the results from the university projects as full or associate members. The annual fee of $50,000 or $10,000 entitles the participants to non-exclusive technology use rights as well as interaction with the university researchers during periodic visits to the various research laboratories throughout Canada.

16.2.2 Joint AOSTRA/ARC Core Research Program

This $3.0 million program is jointly funded by AOSTRA and the Alberta Research Council and has been an ongoing oil sands research program since 1981. As currently structured, the Core Research Program consists of six projects which have been specifically formulated to technical needs identified by industry. The program is based on an annual industry access fee of $60,000 that provides for the non-exclusive use of the technology and for making input to the content and direction of research by direct involvement with the personnel of the Alberta Research Council.

16.2.3 The Data Base Management System

As outlined in Section 1.12, the ADBS II provides full data storage, access, and reporting capabilities for in situ pilot projects. Seven companies operating seven projects are currently using the system. Licensing arrangements are made between AOSTRA and individual companies with system charges being directly related to the volume of data and amount of use. AOSTRA will arrange for a "live demonstration" of system capabilities for interested companies.

17 Publications, Conferences and Workshops

17.1 Publications

- In September, 1987 AOSTRA appointed a new Editor for the quarterly newsletter the TAR paper. The newsletter strives to keep its readership apprised of AOSTRA's activities as well as related activities in the province, and is available at no cost, upon request.
- The fourth technical report of the AOSTRA Technical Publication Series - *Oil Sands Composition and Behavior Research* was published in September, 1987. Work also began on number five of this series and on the third report of a series being published under the auspices of the AOSTRA-United States Memorandum of Understanding. Both reports will be available in mid-1988.
- The proceedings of the Third International Conference on Heavy Crude and Tar Sands, Long Beach, California, July 1985, will be published by AOSTRA and made available during the Fourth International Conference to be held in August 1988.
- The AOSTRA Journal of Research continues to publish quarterly. The articles are concentrated on oil sands, heavy oils, oil source rocks, and tertiary recovery of conventional petroleum.

All of the above publications can be obtained through the AOSTRA Library and Information Services.

17.2 Conferences and Workshops

- In June, 1987 AOSTRA's annual spring conference was held at the Edmonton Convention Center during Intercan Week. The Technical program featured sessions relating to: In Situ Recovery of Heavy Oil and Oil Sands; Environmental Developments; Upgrading and Co-processing; and Energy Economics.
- In October, 1987 the regular meeting for participants in AOSTRA's University Access Program was held in Banff. This annual meeting allows AOSTRA-supported researchers the opportunity to discuss their work with representatives of the companies which are participating in the program.
- AOSTRA will be hosting the 4th UNITAR/UNDP International Conference on Heavy Crude and Tar Sands in Edmonton in August, 1988. Planning and preparations were ongoing throughout the fiscal year.

18 Economic Analyses

Economic evaluations are utilized by AOSTRA to assist in guiding the direction of research for the development of new and improved technology. Proposed and active research projects are evaluated to determine their potential economic viability, and completed projects are evaluated to establish the potential value of technology that is available for sale or licensing. Economic studies provided by applicants, project participants, and studies developed within AOSTRA are utilized.

During the past year, AOSTRA evaluated several of the active in situ projects using a computer model developed specifically for such evaluations. Several of the projects were also evaluated by the Canadian Energy Research Institute, at AOSTRA's request, to provide an independent evaluation of the projects' potential economic viability. Development of a cost data base was started to provide capital and operating cost data for economic evaluations. AOSTRA continued to participate with other Alberta government agencies in macro-energy modeling studies using models developed by the Alberta Research Council and the Alberta Department of Energy. These studies assist the Alberta Government in determining the role of oil sands and heavy oil in the development of Alberta's energy resources.

19 AOSTRA Library and Information Services (ALIS)

AOSTRA Library and Information Services' multi-disciplinary team of technical information officers and support staff in both Edmonton and Calgary continue to provide fast, accurate information on oil sands, heavy oil and enhanced recovery processes. Hard copies of all material are available at both sites.

In addition, AOSTRA's confidential information has also been computerized and the hard copy filing system is in place. This information consists of:

- AOSTRA/Industry Field Pilot Projects;
- AOSTRA/University Research Program Agreements;
- AOSTRA/Industry Mining, Upgrading, Extraction Projects; and
- AOSTRA/ARC Access Program

ALIS continues to distribute the TAR paper, the AOSTRA Journal of Research and all AOSTRA Publication Series material.

20 Patents

20.1 AOSTRA Patents

The following patents and patent applications are assigned to AOSTRA:

a) Canadian Patents

Patent No.	Date Issued	Patent Title
1,120,418	Mar 23/82	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)
1,121,749	Apr 3/82	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)
1,102,234	Jun 2/81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
1,122,015	Apr 20/82	Process for Microbiologically Leaching Coke (T.R. Jack et al)
1,129,801	Aug 17/82	Alkali Recycle Process for Recovery of Heavy Oils and Bitumens (M.A. Kessick)
1,134,174	Oct 26/82	Two-Phase Wet Steam Flowmeter (1) (D.S. Scott and E. Rhodes)
1,158,458	Dec 13/83	Variable Drive for Pump Jack (D.L. Buckler)
1,120,367	Jun 7/84	Catalytic Sulfur Removal from Hydrocarbons (P.M. Boorman et al)
1,170,444	Jul 10/84	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne and J.D. Tyrer)
1,171,382	Jul 24/84	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R.A. Ritter)
1,844,022	Mar 19/85	Use of Surfactants to Improve Oil Recovery During Steam Flooding (E.E. Isaacs and D.R. Prowse)
1,189,444	Jun 25/85	Additive for Inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)
1,210,358	Aug 26/86	Process for Upgrading a Heavy Viscous Hydrocarbon (I.H. Lutz) (Acres Davy McKee D.M. International, Inc., Houston, Texas)
1,220,646	Apr 21/87	Two-Phase/Flowmeter (2) (D.S. Scott and E. Rhodes)
1,225,129	Aug 4/87	Commutator (R.A. Ritter)

b) Canadian Patent Applications

Application No.	Date Filed	Patent Application Title
369,403-8	Jan 27/87	Wet Combustion Process (D.W. Bennion et al)
379,072	Feb 22/83	Improved Process for Recovery of Residual Bitumen from Tailings from Oil Sand Extraction Plants (E.L. Tollefson and E.S. Hall)

Application No.	Date Issued	Patent Title
491,238	Sep 20/85	Apparatus for Continuously Separating Particulate Solids from Liquid Suspensions (R.A. Ritter)
491,838	Sep 30/85	Method for Controlling Water Coning in Oil Wells (R.W. Luhning and K.R. Ronaghan)
487,714	Jul 29/85	Microwave Induced Catalytic Conversion of Methane to Ethylene and Hydrogen (J. Wan)
517,837	Sep 9/86	Pressure-Up/Blowdown Combustion - A Channelled Reservoir Recovery Process (R.J. Hallam and J.K. Donnelly)
502,573	Feb 2/86	Method for Obtaining Horizontal Fractures in an Oil Reservoir (T. Harding et al)
552,801	Nov 19/87	Microbial Process for Selectively Plugging a Sub-terranean Formation (J.W.F. Costerton)
552,920	Nov 26/87	Steam Drive/Oil Recovery Process Involving Horizontal Boreholes (P. Toma)

c) U.S. Patents

Patent No.	Date Issued	Patent Title
4,180,455	Dec 25/79	Process for Thermally Cracking a Heavy Hydrocarbon (W. Taciuk)
4,280,879	Jul 28/81	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)
4,306,961	Dec 22/81	Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk - Tarsand Version)
4,285,773	Aug 25/81	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk - Lloydminster Version)
4,312,234	Jan 26/82	Two-Phase Wet Steam Flow Meter (1) (D.S. Scott and E. Rhodes)
4,271,905	Jun 9/81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
4,438,218	Mar 20/84	Catalytic Sulfur Removal from Hydrocarbons (P.M. Boorman et al)
4,454,023	Jul/Aug/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)
4,458,759	Jul 10/84	Use of Surfactants to Improve Oil Recovery During Steam Flooding (E.E. Isaacs and D.R. Prowse)
4,487,264	Dec 11/84	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne and J.D. Tyrer)
4,501,648	Feb 26/85	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R.A. Ritter)
4,506,733	Mar 26/85	Additive for Inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)

Patent No.	Date Issued	Patent Application Title
4,574,643	Mar 11/86	Two-Phase Wet Steam Flowmeter (2) (D.S. Scott and E. Rhodes)
4,574,038	Mar 4/86	Microwave Induced Catalytic Conversion of Methane to Ethylene and Hydrogen (J. Wan)
4,623,203	Nov 18/86	Commutator (R.A. Ritter)
4,623,442	Nov 18/86	Apparatus for Continuously Separating Particulate Solids from Suspensions (R.A. Ritter)

d) U.S. Patent Applications

Application No.	Date Filed	Patent Application Title
229,349	Jan 29/81	Wet Combustion Process (D.W. Bennion et al)
06/294,523	Aug 20/81	Variable Speed Pump Jack (D.L. Buckler)
784,933	Oct 7/85	Method for Controlling Water Coning in Oil Wells (R.W. Luhning and K.R. Ronaghan)
834,177	Feb 2/86	Method for Obtaining Horizontal Fractures in an Oil Reservoir (T. Harding et al)
908,306	Sep 17/86	Pressure-up/Blowdown Combustion - A Channelled Reservoir Recovery Process (R.J. Hallam and J.K. Donnelly)
122,814	Nov 19/87	Microbial Process for Selectively Plugging a Sub-terranean Formation (J.W.F. Costerton)
132,803	Dec 14/87	Steam Drive/Oil Recovery Process Involving Horizontal Boreholes (P. Toma)

e) Venezuela Patents

Patent No.	Date Issued	Patent Title
991/80	Jun 10/80	Process for Microbiologically Leaching Coke (J. Zajic/Sullivan)
785/81	May 9/81	Two-Phase Wet Steam Flow Meter (D.S. Scott and E. Rhodes)
108/82	Jan 22/82	Wet Combustion Process (D.W. Bennion, R.G. Moore, and K. Donnelly)
1299/82	Jul 21/82	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne/J.D. Tyrer)
1803/83	Nov 11/83	Additive for inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)
1993/79	Aug 7/86	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-containing Liquids (W. Taciuk)

f) Venezuela Patent Applications

Application No.	Date Filed	Patent Application Title
0067	Jan 21/81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
264	Feb 25/80	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)

g) Mexico Patent Applications

Application No.	Date Filed	Patent Application Title
179,758	Oct 24/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)
200,744	Mar 22/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)

h) European (EEC) Patents

Patent No.	Date Issued	Patent Title
0-028-666	Apr 6/83	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk) (Belgium, France, Italy, Netherlands, and U.K.)
79,302542.0		(Sweden)
29-65-154.5		(Germany)
81.304752.9	Oct 13/81	Two-Phase Flowmeter (1) (D.S. Scott and E. Rhodes)
84.301888.8	Mar 20/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)

i) Argentina Patent Applications

Application No.	Date Filed	Patent Application Title
279,427	Dec 21/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

j) Romania Patent Applications

Application No.	Date Filed	Patent Application Title
99095	Oct 30/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

k) Turkey Patent Applications

Application No.	Date Filed	Patent Application Title
144261	Dec 21/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

l) Japan Patent Applications

Application No.	Date Filed	Patent Application Title
138227/79	Oct 25/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

19.2 Prior Company Patents (for which AOSTRA has acquired certain licensing rights)

a) Canadian Patents

	Canadian Patent No.	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
1.	1125649	01-15-82	12-19-79	4234042	Direct Combustion Stimulation of a Producing Well
2.	118341	02-16-82	09-14-79	4272487	Indirect Thermal Stimulation of Producing Wells

b) U.S. Patents

	Canadian Patent No.	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
1.	3964547	06-22-76	10-29-74	972679	Use of Tar as a Diverter in Steaming Operations
2.	4147213	04-03-79	—	—	Combustion Air Injection Well
3.	4234042	11-18-80	06-11-79	1125649	Direct Combustion Stimulation of a Producing Well
4.	4272487	06-23-81	01-01-79	1118341	Indirect Thermal Stimulation of Producing Wells

Tables

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1988

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/87 to March 31/88	Balance
Institutional Research				
Alberta Research Council				
– Information Centre – ALIS	$ 5,068,107	$ 4,283,257	$ 699,180	$ 85,670
– Oil Sands Research Centre	26,748,886	25,248,886	1,430,990	69,010
– Sample Bank	1,600,301	1,408,717	153,423	38,161
– Regional Geological Program	4,175,280	3,635,280	464,075	75,925
– Hydrocarbon Program	2,501,849	2,101,849	374,383	25,617
– Strategic Research Program	2,799,256	1,249,256	1,588,050	(38,050)
– Marcro Energy Modelling	100,000	34,000	17,000	49,000
Inventors Assistance Grant	749,040	510,461	109,000	129,579
University Contracts	28,599,647	23,064,826	3,018,722	2,516,099
Professorships	4,001,109	3,829,631	91,120	80,358
New Graduate Assistance Program	200,000	7,847	65,750	126,403
Post Doctoral Fellowships	100,000	46,040	22,500	31,460
Scholarships and Fellowships	3,480,000	2,407,894	418,639	653,467
Lectureship Program	12,000	–	–	12,000
ARC Access Program	25,000	9,447	723	14,830
University Access Program	175,000	174,263	(95)	832
Program Planning and Evaluation	500,000	326,620	–	173,380
Petroleum Recovery Institute	3,889,252	3,187,568	700,000	1,684
Centre for Frontier Engineering Research	50,000	25,000	25,000	–
Computer Modelling Group	440,000	220,000	220,000	–
Unitar Conference	379,000	65,605	104,588	208,807
Completed Projects	2,371,643	2,371,643	–	–
	$ 87,965,370	$ 74,208,090	$ 9,503,048	$ 4,254,232
Mining and Extraction				
Retorting				
– Umatac	$ 16,750,481	$ 15,369,961	$ 1,378,265	$ 2,255
Nova/Husky/Canstar	176,700	143,549	33,151	–
Shell Canada/Solv-ex	3,500,000	2,843,900	428,807	227,293
Terra Energy Sesa Project	500,000	–	70,387	429,613
Tzipa Enterprizes-Ostex Process	100,000	–	9,918	90,082
Esso Resources	450,000	–	337,780	112,220
Completed Project	7,106,588	7,106,588	–	–
	$ 28,583,769	$ 25,463,998	$ 2,258,308	$ 861,463

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1988
(continued)

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/87 to March 31/88	Balance
In Situ Oil Sands				
Peace River				
— Shell	$ 75,039,351	$ 74,628,910	$ 113,028	$ 297,413
Athabasca				
— Amoco	24,947,108	23,819,675	(27,148)	1,154,581
— Amoco/Petro-Canada	17,108,250	11,893,754	2,069,863	3,144,633
— Canterra Energy Ltd.	46,861,000	27,772,054	8,700,700	10,388,246
Cold Lake				
— B.P.	25,596,000	23,851,594	82,402	1,662,004
— B.P./Petro-Canada	1,499,250	1,150,149	–	349,101
— Bow Valley Industries	13,862,000	11,245,377	841,980	1,774,643
— Suncor – Ft. Kent	400,000	118,979	–	281,021
Alpha Engineering	6,250	–	1,000	5,250
Simtech Consulting	35,000	28,332	4,299	2,369
W.T.C. Water Treatment Project	700,000	–	340,400	359,600
Shell Water Treatment Project	700,000	–	678,297	21,703
Engineering Studies Program	100,000	–	19,118	80,882
Completed Projects	9,599,999	9,599,999	–	–
	$216,454,208	$184,108,823	$ 12,823,939	$ 19,521,446
Underground Access				
Athabasca				
— U.T.F. Project	$ 61,281,948	$ 51,058,659	$ 3,764,839	$ 6,458,450
— Completed Project	5,108,263	5,108,263	–	–
	$ 66,390,211	$ 56,166,922	$ 3,764,839	$ 6,458,450
Carbonate Trend				
Buffalo Creek				
— Union Oil	$ 31,185,000	$ 30,891,950	$ 255,743	$ 37,307
Completed Project	308,082	308,082	–	–
	$ 31,493,082	$ 31,200,032	$ 255,743	$ 37,307
Heavy Oil				
Petro-Canada	$ 14,308,046	$ 13,922,435	$ (29,809)	$ 415,420
Alberta Energy Company	6,684,500	6,257,070	165,875	261,555
Norcen International Ltd.	6,750,000	7,030,260	$ (1,188,165)	$ 907,905
PanCanadian Petroleum	1,500,000	695,073	66,140	738,787
Completed Project	239,674	239,674	–	–
	$ 29,482,220	$ 28,144,512	$ (985,959)	$ 2,323,667

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1988

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/87 to March 31/88	Balance
Enhanced Recovery Conventional Oil				
Vikor Resources Ltd.	$ 4,000,000	$ 3,320,267	$ (22,200)	$ 701,933
Hudson's Bay Oil & Gas	2,462,500	1,567,643	277,211	617,646
Robinson Slim Tube Test	169,240	7,559	116,049	45,632
Canterra's Solids Disposition Project	99,250	81,213	18,037	–
Saskatchewan Research Council	15,000	–	10,000	5,000
Westgrowth Petroleums Ltd.	600,000	600,000	(43,500)	43,500
P.R.I. EOR Initiatives Program	400,000	–	–	400,000
Gulf Canada Resources Ltd.	807,283	–	269,094	538,189
Completed Projects	1,033,391	1,033,391	–	–
	$ 9,586,664	$ 6,610,073	$ 624,691	$ 2,351,900
Bitumen Upgrading				
Residue Utilization Project	$ 1,398,232	$ 1,021,337	$ 161,169	$ 215,726
Veba Oil – Cold Lake	3,265,000	368,131	2,384,530	512,339
Veba Oil – Athabasca	1,500,000	–	1,147,351	352,649
H.R.I.	1,656,200	1,440,803	–	215,397
Completed Project	17,907,582	17,907,582	–	–
	$ 25,727,014	$ 20,737,853	$ 3,693,050	$ 1,296,111
Technology Handling				
Data Base Administration	$ 3,723,515	$ 3,455,511	$ 240,945	$ 27,059
AOSTRA Journal	419,773	357,216	46,185	16,372
Patent Costs	750,000	500,000	102,620	147,380
AOSTRA Publication Series	28,500	–	9,800	18,700
AOSTRA Technical Handbook	100,000	219	5,000	94,781
Technology Transfer & Commercialization	500,000	–	44,108	455,892
Completed Projects	91,865	91,865	–	–
	$ 5,613,653	$ 4,404,811	$ 448,658	$ 760,184
Training Activities	$ 2,090,000	$ 1,759,648	$ 42,364	$ 287,988
International Activities	$ 1,780,800	$ 1,605,081	$ 77,930	$ 97,789
Authority Costs	$ 2,025,000	$ 1,716,303	$ 298,554	$ 10,143
Totals	$507,191,991	$436,126,146	$ 32,805,165	$ 38,260,680

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Fund Balance

Twelve-Year Summary
For the years ended March 31

	1988	1987	1986
Revenue			
Alberta Heritage Savings Trust Fund	$ 20,800,000	$ 31,400,000	$ 50,000,000
Alberta General Revenue Fund	26,900,000	34,700,000	–
Technology Sales	1,325,060	1,227,125	2,156,404
	$ 49,025,060	$ 67,327,125	$ 52,156,404
Expenditures			
Institutional Research			
Alberta Research Council			
– Information Centre	$ 699,180	$ 591,097	$ 499,620
– Oil Sands Research Centre	1,430,990	1,972,980	3,015,466
– Sample Bank	153,423	155,588	157,118
– Regional Geological Program	464,075	517,955	309,345
– Hydrocarbon Program	374,383	773,341	797,636
– Strategic Research Program	1,588,050	1,249,256	–
– Marcro Energy Modelling	17,000	17,000	17,000
Inventors Assistance Grant	109,000	82,562	117,119
University Contracts	3,018,722	2,952,754	2,869,781
Professorships	91,120	411,389	493,856
New Graduate Assistance Program	65,750	7,847	–
Post Doctoral Fellowships	22,500	–	22,500
Scholarships and Fellowships	418,639	336,883	411,063
Lectureship Program	–	–	–
ARC – Access Program	723	1,213	3,476
University Access Program	(95)	8,697	17,975
Program Planning and Evaluation	–	54,243	66,216
Petroleum Recovery Institute	700,000	1,000,000	1,125,562
Centre for Frontier Engineering Research	25,000	–	25,000
Computer Modelling Group	220,000	220,000	–
Unitar Conference	104,588	65,605	–
Completed Projects	–	67,984	341,252
	$ 9,503,048	$ 10,486,394	$ 10,289,985

1985	1984	1982 and Prior	Total
$ 50,000,000	$ 54,500,000	$196,949,032	$403,649,032
–	–	–	61,600,000
2,056,808	1,988,107	9,421,893	18,175,397
$ 52,056,808	$ 56,488,107	$206,370,925	$483,424,429
$ 551,962	$ 495,183	$ 2,145,396	$ 4,982,438
2,915,270	3,236,077	14,109,093	26,679,876
93,205	134,761	868,044	1,562,139
753,092	642,157	1,412,730	4,099,354
530,872	–	–	2,476,232
–	–	–	2,837,306
–	–	–	51,000
180,780	130,000	–	619,461
2,994,843	3,152,248	11,095,201	26,083,549
560,622	461,515	1,902,248	3,920,750
–	–	–	73,597
22,500	1,040	–	68,540
388,920	383,807	887,221	2,826,533
–	–	–	–
514	4,244	–	10,170
13,861	35,918	97,813	174,169
85,675	120,486	–	326,620
547,690	514,315	–	3,887,567
–	–	–	50,000
–	–	–	440,000
–	–	–	170,193
949,244	963,940	49,224	2,371,644
$ 10,589,050	$ 10,275,691	$ 32,566,970	$ 83,711,138

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Fund Balance

Twelve-Year Summary
For the years ended March 31
(continued)

	1988	1987	1986
Mining and Extraction			
Retorting			
— Umatac	$ 1,378,265	$ 1,182,251	$ 2,460,548
Nova/Husky/Canstar	33,152	121,129	22,420
Shell Canada/Solv-Ex	428,807	2,843,900	–
Terra Energy Sesa Project	70,386	–	–
Tzipa Enterprizes-Ostex Process	9,918	–	–
Esso Resources	337,780	–	–
Completed Project	–	890,685	1,598,408
	$ 2,258,308	$ 5,037,965	$ 4,081,376
In Situ Oil Sands			
Peace River			
— Shell	$ 113,028	$ 12,299,010	$ (1,572,687)
Athabasca			
— Amoco	(27,148)	5,432	(47,191)
— Amoco/Petro-Canada	2,069,863	3,953,698	2,013,365
— Canterra Energy Ltd.	8,700,700	3,299,311	3,063,138
Cold Lake			
— B.P.	82,402	2,589,985	2,692,069
— B.P./Petro-Canada	–	35,349	281,730
— Bow Valley Industries	841,980	2,833,056	2,397,730
— Suncor – Ft. Kent	–	37,883	(9,284)
Alpha Engineering	1,000	–	–
Simtech Consulting	4,299	9,442	18,890
W.T.C. Water Treatment Project	340,400	–	–
Shell Water Treatment Project	678,297	–	–
Engineering Studies Program	19,118	–	–
Completed Projects	–	19,045	108,218
	$ 12,823,939	$ 25,082,211	$ 8,945,978

1985	1984	1982 and Prior	Total
$ 2,948,229	$ 2,800,255	$ 5,978,678	$ 16,748,226
–	–	–	176,701
–	–	–	3,272,707
–	–	–	70,386
–	–	–	9,918
–	–	–	337,780
600,785	721,130	3,295,580	7,106,588
$ 3,549,014	$ 3,521,385	$ 9,274,258	$ 27,722,306
$ 806,095	$ 3,037,950	$ 60,058,542	$ 74,741,938
(726,689)	(138,706)	24,726,829	23,792,527
5,854,969	71,721	–	13,963,616
15,199,377	20,228	6,190,000	36,472,754
3,474,113	878,015	14,217,411	23,933,995
192,092	101	640,877	1,150,149
5,663,041	111,290	240,260	12,087,357
75,739	14,641	–	118,979
–	–	–	1,000
–	–	–	32,631
–	–	–	340,400
–	–	–	678,297
–	–	–	19,118
1,565,372	4,418,868	3,488,497	9,600,000
$ 32,104,109	$ 8,414,108	$109,562,416	$196,932,761

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Fund Balance

Twelve-Year Summary
For the years ended March 31
(continued)

	1988	1987	1986
Underground Access			
Athabasca			
– U.T.F. Project	$ 3,764,839	$ 11,248,413	$ 15,691,395
– Completed Project	–	–	–
	$ 3,764,839	$ 11,248,413	$ 15,691,395
Carbonate Trend			
Buffalo Creek			
– Union Oil	$ 255,743	$ 2,860,676	$ 2,234,802
Completed Project	–	137	307,439
	$ 255,743	$ 2,860,813	$ 2,542,241
Heavy Oil			
Petro-Canada	$ (29,809)	$ 314,067	$ 316,747
Alberta Energy Company	165,875	585,204	422,242
Norcen International Ltd.	(1,188,165)	6,914,180	17,664
PanCanadian Petroleum	66,140	145,688	99,194
Completed Project	–	–	–
	$ (985,959)	$ 7,959,139	$ 855,847
Enhanced Recovery Conventional Oil			
Vikor Resources Ltd.	$ (22,200)	$ 484,889	$ (698,262)
Hudson's Bay Oil & Gas	277,211	129,714	1,437,929
Robinson Slim Tube Test	116,049	7,559	–
Canterra's Solids Disposition Project	18,037	81,213	–
Saskatchewan Research Council	10,000	–	–
Westgrowth Petroleums Ltd.	(43,500)	600,000	–
Gulf Canada Resources Ltd.	269,094	–	–
Completed Projects	–	2,875	1,476
	$ 624,691	$ 1,306,250	$ 741,143

1985	1984	1982 and Prior	Total
$ 19,452,415	$ 3,376,745	$ 1,289,690	$ 54,823,497
–	21,192	5,087,072	5,108,264
$ 19,452,415	$ 3,397,937	$ 6,376,762	$ 59,931,761
$ 4,380,864	$ 2,950,100	$ 18,465,508	$ 31,147,693
506	–	–	308,082
$ 4,381,370	$ 2,950,100	$ 18,465,508	$ 31,455,775
$ 1,541,199	$ 993,554	$ 10,756,869	$ 13,892,627
349,412	224,545	4,675,668	6,422,946
9,613	3,513	85,289	5,842,094
334,175	116,017	–	761,214
56,470	25,934	157,268	239,672
$ 2,290,869	$ 1,363,563	$ 15,675,094	$ 27,158,553
$ (1,036,981)	$ 4,570,621	$ –	$ 3,298,067
–	–	–	1,844,854
–	–	–	123,608
–	–	–	99,250
–	–	–	10,000
–	–	–	556,500
–	–	–	269,094
(6,439)	613,199	422,280	1,033,391
$ (1,043,420)	$ 5,183,820	$ 422,280	$ 7,234,764

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Fund Balance

Twelve-Year Summary
For the years ended March 31
(continued)

	1988	1987	1986
Bitumen Upgrading			
Residue Utilization Project	$ 161,169	$ 210,187	$ 255,100
Veba Oil – Cold Lake	2,384,530	368,131	–
Veba Oil – Athabasca	1,147,351	–	–
H.R.I.	–	1,440,803	–
Completed Project	–	7,892,461	4,396,543
	$ 3,693,050	$ 9,911,582	$ 4,651,643
Technology Handling			
Data Base Administration	$ 240,945	$ 498,062	$ 480,930
AOSTRA Journal	46,185	45,310	149,749
Patent Costs	102,620	15,730	62,851
AOSTRA Publication Series	9,800	–	–
AOSTRA Technical Handbook	5,000	–	219
Technology Transfer & Commercialization	44,108	–	–
Completed Projects	–	–	–
	$ 448,658	$ 559,102	$ 693,749
Training Activities	$ 42,364	$ 219,758	$ 270,129
International Activities	$ 77,930	$ 71,687	$ 109,690
Authority Costs	$ 298,554	$ 448,223	$ 471,612
	$ 32,805,165	$ 75,191,537	$ 49,344,788
Excess of Revenue over Expenditures	$ 16,219,895	$ (7,864,412)	$ 2,811,616
Fund Balance at Beginning of Period	$ (1,726,778)	$ 6,137,634	$ 3,326,018
Fund Balance at End of Period	$ 14,493,117	$ (1,726,778)	$ 6,137,634

1985	1984	1982 and Prior	Total
$ 521,675	$ 23,730	$ 10,645	$ 1,182,506
–	–	–	2,752,661
–	–	–	1,147,351
–	–	–	1,440,803
591,994	1,014,023	4,012,561	17,907,582
$ 1,113,669	$ 1,037,753	$ 4,023,206	$ 24,430,903
$ 502,730	$ 654,653	$ 1,319,135	$ 3,696,455
124,471	32,353	5,334	403,402
68,142	110,307	242,970	602,620
–	–	–	9,800
–	–	–	5,219
–	–	–	44,108
–	–	91,865	91,865
$ 695,343	$ 797,313	$ 1,659,304	$ 4,853,469
$ 243,757	$ 328,732	$ 697,273	$ 1,802,013
$ 444,666	$ 325,160	$ 653,879	$ 1,683,012
$ 37,726	$ 121,980	$ 636,762	$ 2,014,857
$ 73,858,568	$ 37,717,542	$200,013,712	$468,931,312
$(21,801,760)	$ 18,770,565	$ 6,357,213	$ 14,493,117
$ 25,127,778	$ 6,357,213	–	–
$ 3,326,018	$ 25,127,778	$ 6,357,213	$ 14,493,117

Auditor's Report and Financial Statements

Alberta Oil Sands
Technology and Research Authority
Oil Sands Technology and Research Fund
Financial Statements
March 31, 1988

Auditor's Report

Balance Sheet

Statement of Revenue, Expenditure and Fund Balance

Notes to the Financial Statements

ALBERTA LEGISLATURE

OFFICE OF THE AUDITOR GENERAL

Auditor's Report

To the Members of the Alberta Oil
Sands Technology and Research Authority

I have examined the balance sheet of the Alberta Oil Sands Technology and Research Authority – Oil Sands Technology and Research Fund as at March 31, 1988 and the statement of revenue, expenditure and fund balance for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances.

In my opinion, these financial statements present fairly the financial position of the Fund as at March 31, 1988 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Donald D. Salmon

C.A.
Auditor General

Edmonton, Alberta
June 24, 1988

Alberta Oil Sands Technology and Research Authority
Oil Sands Technology and Research Fund

Balance Sheet

As At March 31, 1988

ASSETS	**1988**	**1987**
Current:		
Cash	$15,164,220	$16,058,465
Deposits on projects, net (Note 3)	297,321	1,703,743
Accounts receivable	4,779,356	2,444,794
Prepaid expense	–	2,111
	$20,240,897	$20,209,113

LIABILITIES AND FUND BALANCE

Current:		
Accounts payable	$ 4,842,344	$20,835,267
Holdbacks payable	905,436	1,100,624
	5,747,780	21,935,891
Fund balance (deficit)	14,493,117	(1,726,778)
	$20,240,897	$20,209,113

The accompanying notes are part of these financial statements.

Alberta Oil Sands Technology and Research Authority
Oil Sands Technology and Research Fund

Statement of Revenue, Expenditure and Fund Balance

For The Year Ended March 31, 1988

	1988	1987
Revenue:		
Contributions by the Province of Alberta:		
— Heritage Savings Trust Fund	$20,800,000	$31,400,000
— General Revenue Fund	26,900,000	34,700,000
Technology sales	1,325,060	1,227,125
	49,025,060	67,327,125
Expenditure:		
In situ oil sands, net (Notes 7 and 8)	12,823,939	25,082,211
Institutional research	9,503,048	10,486,394
Underground access (Note 8)	3,764,839	11,248,413
Bitumen upgrading	3,693,050	9,911,582
Mining and extraction	2,258,308	5,037,965
Enhanced recovery (Note 7)	624,691	1,306,250
Technology handling	448,658	559,102
Authority costs	298,554	448,223
Carbonate trend	255,743	2,860,813
International activities	77,930	71,687
Training activities	42,364	219,758
Heavy oil, net (Notes 7 and 8)	(985,959)	7,959,139
	32,805,165	75,191,537
Excess (deficiency) of revenue over expenditure for the year	16,219,895	(7,864,412)
Fund balance at beginning of year	(1,726,778)	6,137,634
Fund balance (deficit) at end of year	$14,493,117	$(1,726,778)

Notes to the Financial Statements

March 31, 1988

Note 1 Authority

The Alberta Oil Sands Technology and Research Authority operates under the authority of the Oil Sands Technology and Research Authority Act, Chapter 0-6, Revised Statutes of Alberta 1980.

Note 2 Significant Accounting Policies

Expenditures from the Fund are not capitalized due to the intangible nature of assets that may accrue to the Authority. The Authority will be entitled to share in any assets remaining at the end of a project in proportion to its percentage of participation. A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Deposits on Projects

The amount of $297,321 (1987 $1,703,743) shown on the balance sheet represents the excess of cash calls on projects over actual expenditures.

Note 4 Administration Costs

The following costs incurred in the administration of the Authority have been borne by the General Revenue Fund and are not reflected in these financial statements.

	1988	1987
Salaries and wages	$2,218,362	$2,249,489
Rental of property and equipment	379,285	404,603
Fees and commissions	323,430	410,978
Employee benefits	306,430	290,388
Travelling and hospitality	151,985	235,158
Materials and supplies	63,942	49,051
Telephone and telegraph	13,670	14,805
Furniture and equipment purchases	9,694	12,345
Advertising	8,774	4,123
Freight, express and postage	8,235	14,263
Equipment maintenance	7,907	10,624
Grants	2,600	–
Staff relocation costs	–	29,229
	$3,494,314	$3,725,056

Note 5 Commitments

The Authority had outstanding commitments as at March 31, 1988 totalling $38,260,680 (1987 $60,448,633) for approved projects.

Note 6 Contingent Liabilities

The Authority is involved in a number of legal proceedings. Claims against the Authority in these proceedings, which have not been reflected in the financial statements, amount to approximately $6,800,000. While the ultimate outcome of these proceedings cannot be determined at this time, it is the opinion of management that the disposition of these cases will have a minor effect on the financial position of the Authority.

Note 7 Potential Recoveries

The following amounts represent potential future recoveries:

	1988	1987
Shell Canada Resources Limited (In situ oil sands)		
– PRISP Project	$12,200,000	$12,200,000
– Sale of 50% interest in PRISP Project	12,200,000	12,200,000
Norcen International (Heavy oil)		
BODO Steam Pilot Project	5,800,000	6,900,000
Vikor Resources (Enhanced recovery)		
Joffre Project	3,300,000	3,300,000
	$33,500,000	$34,600,000

Recovery of these amounts is dependent on generation of sufficient revenue by the projects. Due to the uncertainty concerning the amount of revenue which may ultimately be generated, these amounts have not been included as a receivable in these financial statements and will be offset against expenditures in the year of receipt.

Note 8 Reduction of Expenditure

Current year expenditure has been reduced as follows:

a) In situ oil sands has been reduced by sales of project production as defined in agreements.

b) Underground access has been reduced by $4,520,870, the amount received from participants in the UTF project.

c) Heavy oil has been reduced by sales of project production as defined in agreements and recoveries of $1,188,165 from Norcen International.

Note 9 Approval of Financial Statements

These financial statements were approved by management.